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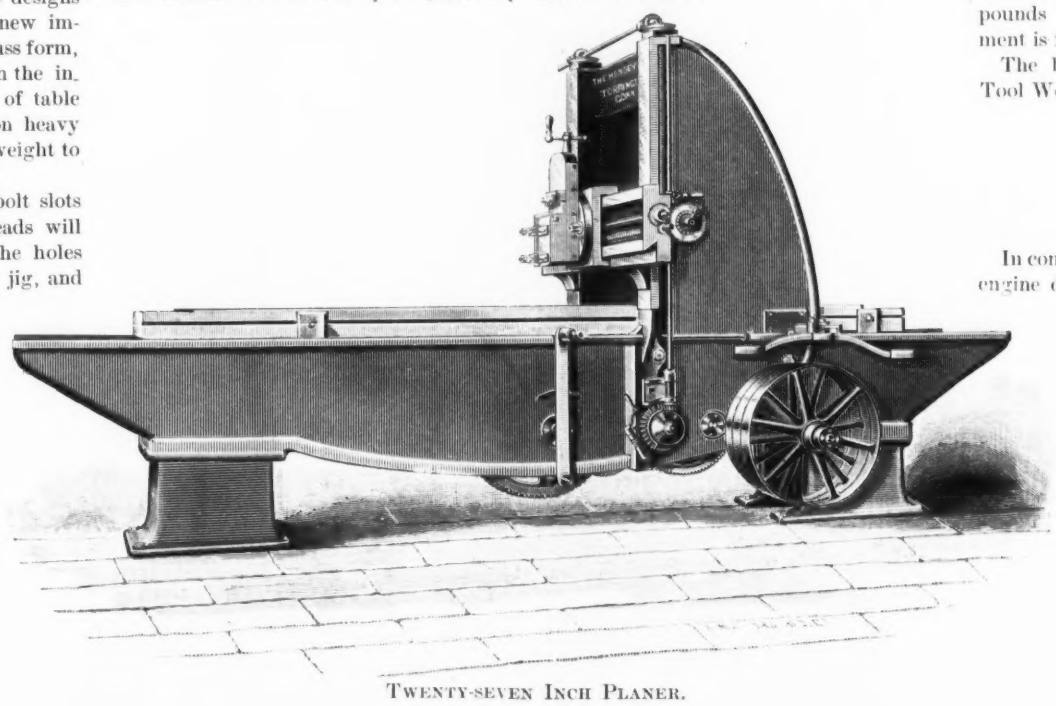
Twenty-Seven Inch by Twenty-Seven Inch by Eight Foot Planer.

This planer is from entirely new designs and patterns, and embodies several new improvements. The bed is made in truss form, very deep and strong, well braced on the inside, long in proportion to length of table (being 12 feet long), and supported on heavy box legs well under, to carry the weight to best advantage.

The table is heavy, and has three bolt slots planed from solid metal, and bolt heads will pass from end to end with ease. The holes in table are drilled and reamed by jig, and are square across. The uprights have sufficient weight and width to resist the heavier cuts when the crosshead is at its full height. The girt between top of uprights is wide and well fastened, and adds materially to their strength. The table receives back and forward motion from an open and cross belt, through a train of cut gears and rack. The driving pulleys are of large diameter, and the proportion of belt speed to speed of table is 60 to 1; one belt shifts ahead of the other.



TWENTY-SEVEN INCH PLANER.

The gears are carried on steel shafts. The feed is arranged to work in all directions, and is adjustable from 0 to ⅝-inch; the feed is obtained by an oscillating disk controlled by stops, and is adjusted by worm and screw, as shown in cut, and can be quickly set. The up and down feed can be operated by hand from either end of the crosshead, which is convenient when the crosshead is high. Raising or lowering the crosshead does not in any way affect the feed. The machine will plane full length between the pockets on the ends of table. The countershaft has 12 by 3-inch pulleys. The weight of the planer is 6,700 pounds.

The manufacturers are the Hendey Machine Company, Torrington, Conn.

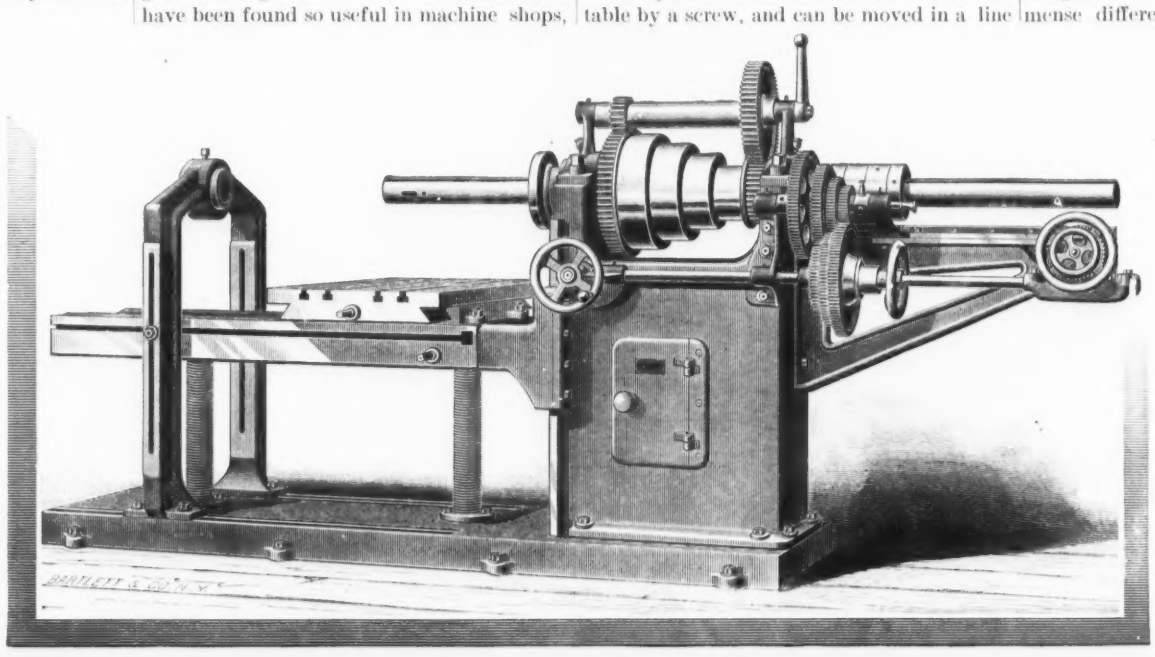
It is stated that the imports of agricultural machinery in Russia are falling off. This is ascribed partly to the impoverishment of the landed proprietors, and partly to the bad harvests in those districts where expensive machines, such as threshing machines and reapers, are used. The trade is now limited to the purchase of cheap plows, harrows, and winnowing machines, and a few seed drills. The imports of agricultural implements are likely to decrease further, as the duty was raised last November. The increased tariff does not, however, apply to machinery worked by a separate steam engine.

In regards to British export trade, it is stated that the silver plating and cutlery houses in Sheffield are doing as well as could be expected at this time of the year. The foreign demand is fairly well maintained. South America is still a good customer to many leading houses. One firm, for which the South American market is special, recently had an order which amounted to about 3,000 dozen files. Stove-grate makers are feeling the beneficial influence of the spring orders; garden tools are being sought after, and spades and shovels are having a heavy demand. Even the engineering and wire trades, so long depressed, are enjoying a share of the improved condition of trade.

Horizontal Drilling and Boring Machine.

We illustrate herewith a new boring machine, which, while it conforms to the general design of tools of its class which have been found so useful in machine shops, has some new features of interest to mechanics.

It is a strong and powerful machine, the spindle being of hard steel 3¼ inches diameter, the largest step of cone 17¾ inches, and the back gearing being 1 to 12. The extreme swing over the platen is 60 inches, and over the bed 72 inches.



HORIZONTAL DRILLING AND BORING MACHINE.

The bar has three rates of feed in either direction by gearing, and a rack and pinion movement, and in feeding is gripped by a friction clamp, so that by releasing the clamp and taking another grip, a very long feed may be obtained. The extreme feed is about five feet, and the feed without change is thirty-four inches. It may also be fed by hand, either with quick or slow motion. As will be seen, the screws for elevating the table are very large, and can be operated either from the end or from the side at pleasure; they are made of steel.

The platen has a movement across the table by a screw, and can be moved in a line parallel with the boring bar and clamped in any desired position. The yoke is also movable, and can be fastened at any desired distance from the head and clamped to the side of the table, making the whole arrangement very rigid.

The machine is built with either a six or a nine foot table, weighing 7,500, and 8,500 pounds respectively, and a facing attachment is furnished when desired.

The builders are the Newark Machine Tool Works, East Newark, New Jersey.

Compound Engines.

BY W. H. BOOTH.

FIFTH PAPER.

In connection with the subject of compound engine design, the weight and speed of the moving parts demand consideration. In the days of comparatively slow-moving engines the inertia of the moving parts, such as the piston, crosshead and part of rod, was a quantity of comparatively little moment, for the necessary accelerative force was but a small portion of the initial steam pressure upon the piston. As piston speeds increased the amount of force necessary to set the piston in motion at the commencement of every stroke was largely increased, and in many cases we may well suppose that a portion of the necessary force of acceleration would be obtained from the fly-wheel, so causing a possible knock in the crank-pin due to the reverse of pressure thereon at the time the steam pressure was more than sufficient to supply the necessary accelerative force. However important the modern theory of the dynamics of the steam engine may be—and there are some who entirely dispute the theory of inertia as practically applied to the steam engine, and treated upon by Charles T. Porter and others—it is certain that in compound engines, which are so frequently built to the same patterns as simple engines in regard to weight of moving parts, there must be an immense difference in the action of the steam on a large low-pressure piston of, say, 50 inches diameter, than when this same piston, at the same speed, is acting as the piston of a simple instead of a compound engine.

In the two cases we will suppose an initial pressure of 100 pounds to the square inch, and we will suppose such a speed and weight of parts that the initial accelerative force requisite to move the piston from a state of rest will absorb 30 pounds per square inch of piston area. Now, in the case of the simple engine, we have 100 pounds minus 30 pounds, or a surplus of 70 pounds pressure to pass onward to the crank-pin as turning effort, the absorbed 30 pounds, of course, being given out during the period of retardation of the piston. In the compound engine how different is the case. In an ordinary case, starting with 100 pounds, we should probably expand in the first

cylinder to about 30 pounds, and we should only obtain, say, 28 pounds of forward pressure on the large piston. We have actually to call on the crank to supply the initial moving force, and we thus transfer all the forward steam pressure to the latter half of the stroke, which should never be the case, for in every case the looseness at pins and cross-heads should invariably be taken up, before the passage of the crank-pin over the dead centers, by cushioning of the exhaust or lead of the steam. Now, it is very common for an engine builder to erect a compound engine to run at just the same speed as if it were the simple engine of like speed and weight which he erected a few months before; and yet how different the circumstances in the two cases; in the one a high piston speed, with a good starting pressure; in the other, very little pressure indeed. In the high pressure or small cylinder of the compound engine the same discrepancy is seen; for except that the piston may have a high pressure upon it per inch of area, the total piston load is small, and the rods are perhaps of equal weight as those of the large cylinder alongside. Hence it is that, dynamically considered, a lower rate of piston speed is proper for compound than for simple engines built, as so usually they are, from the same patterns.

To properly apportion the weights of the two pistons of a compound engine so as to be equally placed as regards this matter of inertia, is not difficult, but by reducing speed alone can the proper proportion of initial absorption be maintained between the two types of engine.

Speaking generally, I should be inclined to award the preference to the tandem type of compound engine with both high and low pistons on one rod. It would be out of the scope of this series of papers to enter specially into the question of inertia. The purpose will be sufficiently served in drawing attention to the great differences which compound working necessarily must bring about in the steam action considered dynamically. So far, it is probable that few engines are at work of any type wherein all initial steam pressure is absorbed by the inertia of the pistons and moving parts. With some high-speed engines, however, the limit must be very near, and beyond this limit the dynamic question will undoubtedly make itself heard. It is curious to reflect in this connection that when a high-speed piston requires to be started from rest by a pull from the crank-pin, the employment of cushioning of the exhaust steam may prove a source of uneasy working, and require to be reduced or entirely abolished.

It was probably due to the enormous weights of the old-fashioned beam engines, with heavy cast-iron beams, that such excellent results in steadiness of turning and freedom from noise were obtained, but in these engines the speed was low and the pressure certainly greater than that in the large cylinder of a modern compound horizontal engine. The two cases are, therefore, not at all parallel, and therefore it is of importance, so far as the dynamic principle has any force or reason, that compound engine design be based on a recognition of the differences introduced by the compound system itself.

It is said that a teaspoonful of chloride of zinc in two ounces of alcohol will make a soldering fluid that will not tarnish or rust the work.

The output of iron ore in New Jersey, for the year 1887, was 547,889 tons.

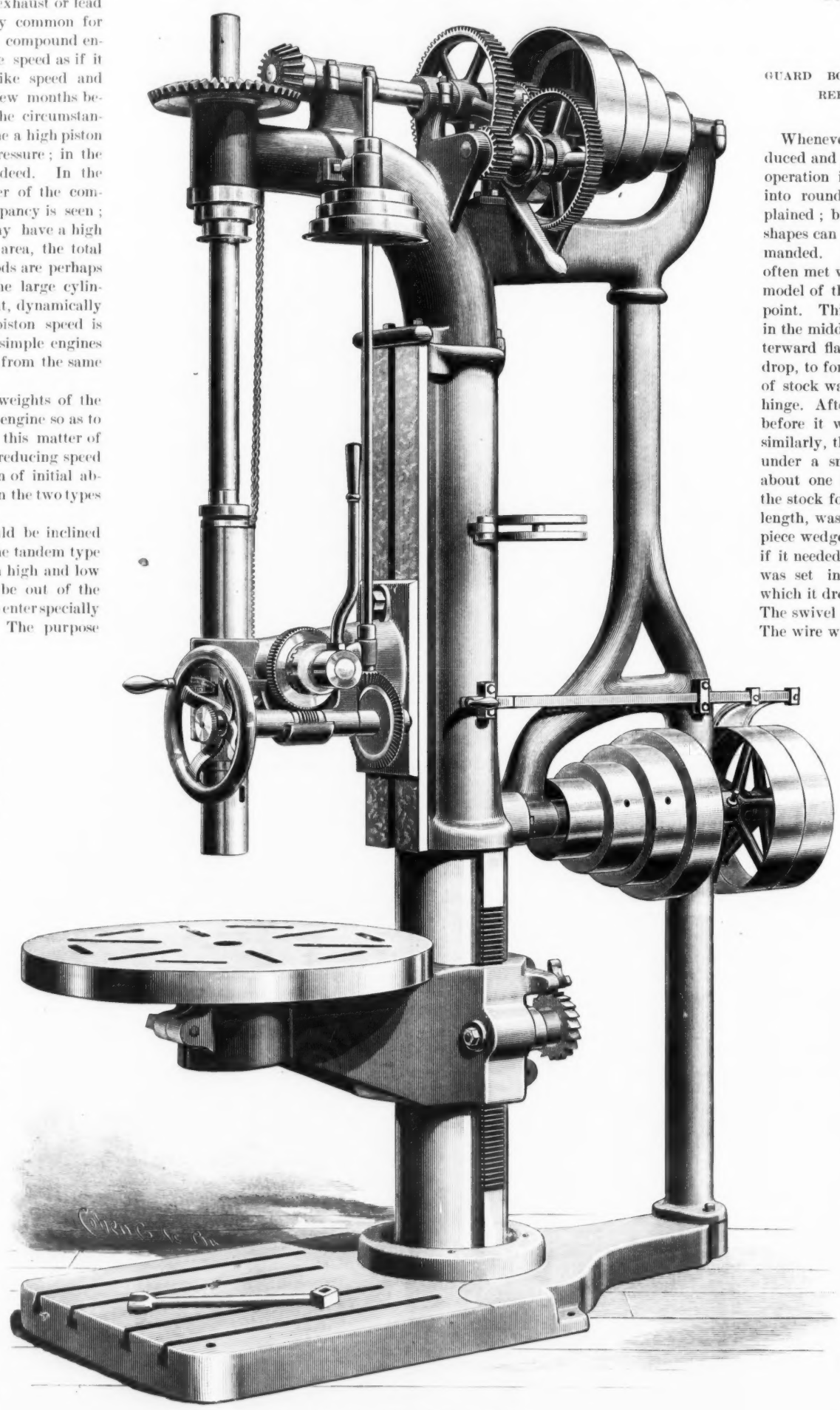
New Upright Drill Press.

We herewith illustrate a back geared and power feed drill press, made from entirely new patterns, with latest and best improvements, by Lodge, Davis & Co., Cincinnati, Ohio.

It is heavily braced from the top to the base at the rear, which prevents the column from being forced backward during the strain of heavy drilling, and also gives to the entire machine strength and solidity.

It is fitted with new quick return, which is operated by the right hand alone, leaving the left hand of the operator free to retain its hold upon the work. The spindle is balanced to prevent back lash; and is of steel, extra large. The cones and bevel gears are large, the latter being cut from the solid. The sliding head is balanced, thus preventing it from falling when the bolts are loosened. All shafts and studs are made of steel, and all nuts are case-hardened to reduce wear. The tables are conveniently slotted, and base plates have T-slots in them, of suitable size to admit bolts for clamping.

A swinging bracket is furnished, in which holes can be bored to hold drills, taper sockets, chucks, etc. An index plate is also attached, showing speeds at which drills of different sizes should be run for drilling iron, steel or brass. These drill presses are made 25-inch, 28-inch, 32-inch, and 40-inch.



New Upright Drill Press.

The New Orleans *Times-Democrat* says:

The labor problem on the Pacific coast has assumed a new phase. Employers of unskilled labor in California having reached the conclusion that the wages demanded by the Chinese are extortionate, have sent agents to the South to engage negroes to take the place of the Mongolians. The first consignment of negro laborers passed through St. Louis en route to the coast on Saturday. Reports say that the negroes thought they were being sold into slavery, and had to be kept under lock and key to prevent their flight. But why they consented to go at all, if such was their impression, or by what authority they were kept under lock and key, and forced to go against their will, is not apparent.

Details of Blacksmithing.

By B. F. Spalding.

GUARD BOWS—SWIVELS—BREECH-FRAMES—REFINING IRON IN FORGING.

Whenever there is much stock to be reduced and got into definite different sizes, the operation is easiest performed by getting it into round shapes, for reasons already explained; but it must be provided that these shapes can be converted into the forms demanded. Instances of this kind may be often met with. The guard bow of the last model of the Springfield musket is a case in point. This was drawn round, with a swell in the middle, at a trip-hammer, and was afterward flattened in proper dies with the drop, to form the bow, and the right amount of stock was also placed to form the swivel hinge. After forging, this piece was finished, before it was bent. The swivel was made similarly, the wire for the ring was drawn under a small trip-hammer, which struck about one thousand blows per minute, and the stock for the ends, being cut of the right length, was headed in a foot vise, and the piece wedged, or upset to the right length, if it needed it, which it seldom did, as a stop was set in the vise, at the last heading, which it drove down upon and got gauged. The swivel was also finished before bending. The wire was clamp-milled.

The process of clamp-milling is used to great advantage in finishing many things which are round, and of small diameter, too flimsy to turn or grind, and not of such shape as to be wire-drawn or rolled. "Bosses" on the ends of braces, which are either to be drilled or punched, to receive bolts, are made by forming balls, which, being flattened, assume the required shape.

In the piece represented by Fig. 5 (page 3) this principle was carried about to the extremity of its safe limits. This piece is the breech-frame of a breech-loading rifle, similar to the Snider, but hinged on the other side, the cap of this turning over to the left as shown in Figs. 6 and 7. Fig. 6 represents the side view of the frame, with the cap which hinges over it, and Fig. 7 shows an end view of the same. To make it, a piece was blocked out with the trip-hammer from a 1¼" round bar of good iron, into the shape shown in Fig. 4.

It was not necessary to the procurement of this iron that any one should invade a foreign country and steal the process, as the secret of cast-steel was filched from Huntsman; for iron of very excellent quality—unsurpassable iron—has been made in this country for many years.

One great advantage that this method of working the stock possesses, moreover, was that a good sound welding heat could be taken on the bar at the very beginning, and work put on it to weld it solidly. Those who are but little acquainted with working hot iron have but a vague conception of its nature and consistence, when, as at a welding heat, it is in the pasty condition of partial disintegration. The particles of incandescent iron, which form the fiber of this spongy

mass, hold, in its interstices, all the foreign matter which may be present, diffused in a gaseous or liquid form, which may also, perhaps, float or submerge some solid grains.

A sponge full of water may be squeezed nearly dry with one pressure of the hand, but it is not probable that all the moisture could be pressed out of it, if it was submitted to the pressure of a powerful hydraulic press until its integrity was destroyed, but if put in a dry place the moisture would rapidly disappear by the action of the laws of equilibrium, the wet going to the dry. In order to get out, the water in the center has to trace its way through a very intricate labyrinth among the fibers of the sponge, and as these are pressed closer together the portals of the passage ways are narrowed up, and the exit becomes more and more difficult.

There is not a perfect analogy between the sponge and the hot iron, for there is something in the hot iron that no power can prevent from forcing itself out, which is the heat, and while this remains in up to a certain degree, if the fibers of iron are pressed near enough together to touch, they will unite. As the liquid impurities are trying to get through the interstices, the iron cannot unite at every point, on account of the presence of the impurity, but that iron which unites at the greatest number of points is the best of its kind, and the kind is determined by the quality of its impurities. It does no good to take soft, soaking heats, unless force can be applied to drive out any such gross impurities as can be expelled by mechanical means, and to bring the particles of iron into close proximity to each other, for the promotion of coherence. By turning the iron, and bringing the pressure to bear in different directions, it is kept open, and the slag has a better chance to escape.

As gun barrels were formerly welded under the trip-hammer, all these advantages were obtained, and the welding heats that were taken were sometimes so soft that in putting them under the hammer, on the mandrel on which they were to be welded, the rod would go through the side of the "skelp," instead of through the hole, and the workman would draw it back, and get it into the right place, and weld up a sound barrel. If at any stage the barrel was found defective through the fault of the welder, he was charged one dollar, and a new hand has been known to work a month and come out forty dollars in debt. As this was found to occur from the nature of the work, and not for want of intelligence, painstaking and ordinary trip-hammer skill, this injustice was speedily remedied, and measures were taken to prevent its recurrence, and subsequently gun barrels were welded with rolls.

The remarks upon the refining of iron have been made in this place, not only for their bearing upon this particular case, but for their general bearing, and for future reference.

The breaking down dies used in making the piece shown at Fig. 4, which struck the first blows upon the hot iron, were so shaped as not to confine the stock too closely at the sides to prevent the expulsion of slag, and this process had a refining effect upon the iron. The amount of stock in each part of the piece was calculated, and its equivalent size was determined in round shape. The head required to make it a cylinder $1\frac{1}{2}$" in diameter, and $\frac{5}{8}$" long, the body $1\frac{7}{16}$" diameter and $\frac{7}{8}$" long, and the tang $\frac{9}{16}$" diameter and $3\frac{3}{4}$" long. The stock descended from one size to another with very round shoulders, as any squareness or sharp corners would have been productive of cold shuts or places where one part of the stock shut down over another part, while it might have been too cold to weld. These corners were made so rounding that there was no chance whatever for one part to shut over another, cold or hot, for if this had been allowed there would have been a presumption, amounting to certainty, that in making great numbers there would be some which would get through the processes, unobserved, which would not be welded, and would therefore have cold shuts. When a man who thinks life is worth living, holds the breech of a gun to his shoulder, he wants to be tolerably well satisfied that the force of the coming explosion will be spent in a forward direction; hence no cold shuts were tolerated.

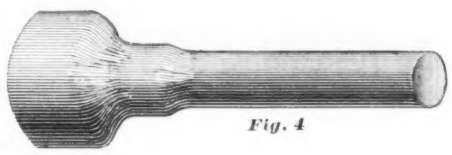


Fig. 4

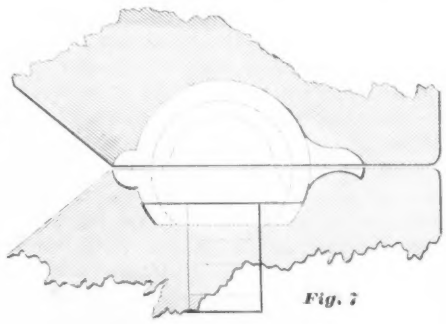


Fig. 7

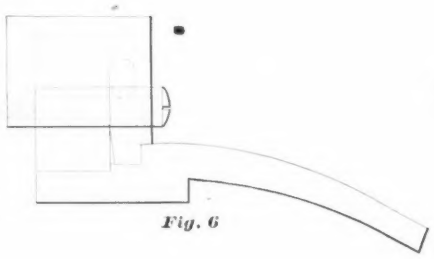


Fig. 6

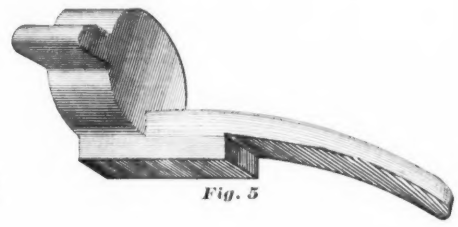


Fig. 5

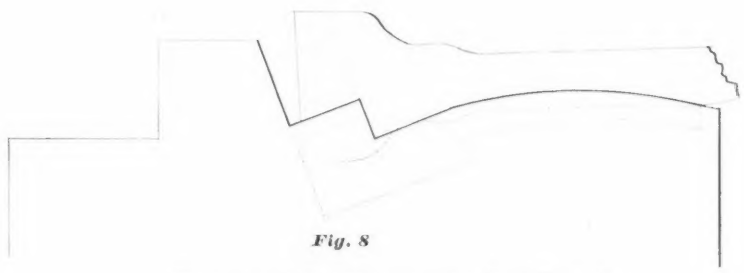
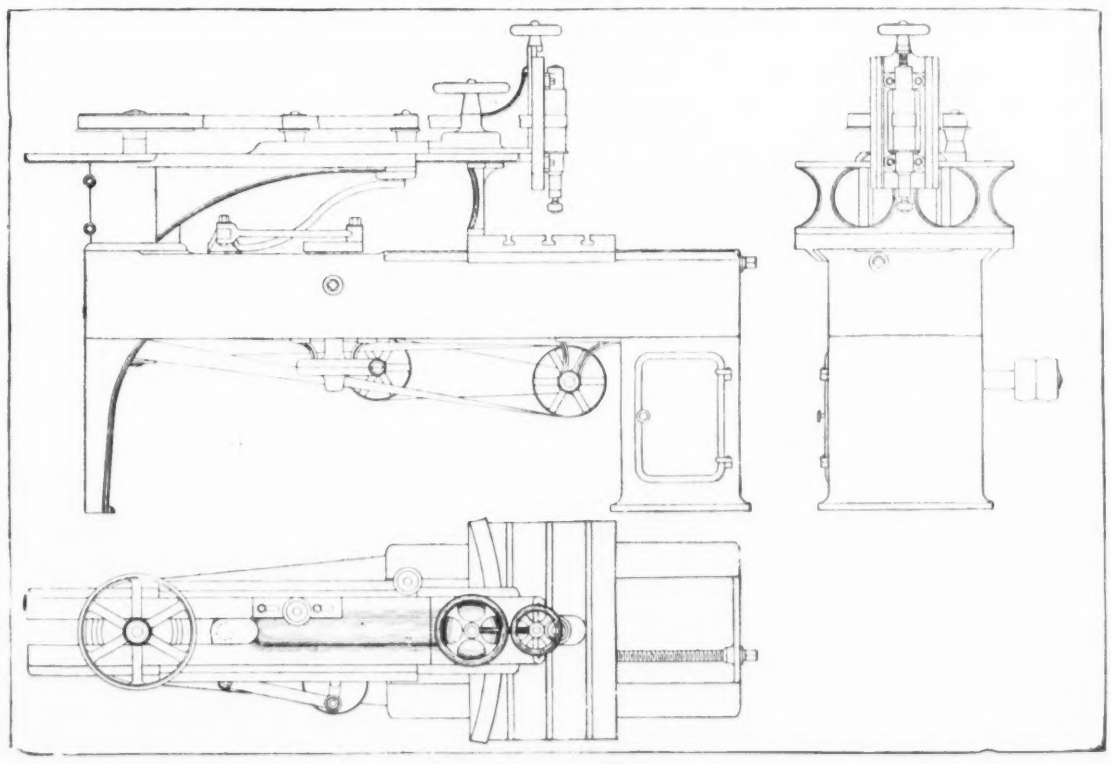


Fig. 8

Details of Blacksmithing.—See Page 2.

After the stock was formed in the shape shown in Fig. 4, another good heat was taken on it, and it was dropped in the die, shown in Fig. 8. This die was made in the form which is represented, for the purpose of getting the force of the blow on it in every direction—except sidewise—for the purpose of giving to it the shape and dimensions which would allow it to enter the finishing die. A good deal of dependence was put upon what is called the flow of the metal, to bring it to this form, and especially to bring out the hinge lug at the side, and it did, in fact, come to shape as well as if the stock had been melted and poured in. A part of the configuration of the faces was designed in the form exhibited, to prevent the dies from moving endwise in the drop, as they had a part of their work to do by a compression which tended to move the dies in that direction, or to force them apart. They were close dies, that is, the stock was restrained within certain limits sidewise, in order to force up the corners of the work, and this caused a fin to be produced. After this was trimmed off they were dropped in a pair of finishing dies, which were made to take them in sidewise. The impression for the hinge lug was made in the upper die, for the convenience of keeping it free from scale. When the frames had been dropped in this die, and again trimmed, the forging was complete.

The complement of this breech frame was a "cap," which was hinged to it, and could be opened to allow the insertion of the cartridge, and when shut formed the breech block. It was supported at the back by the notch in the frame, and at the front by a ledge on the inside, which reached down a short distance over the front end of the frame. A part of the stock, which had to be cut away, could have been easily removed in the process of forging, but this was one of a great many instances where a piece can be finished to better advantage if stock is left on it to allow the tools to make a full cut. It is rather a difficult matter to drill three-quarters of a hole in a piece, and the job can better be done if sufficient stock is given to drill the other quarter. This piece was blocked out solid from a bar $1\frac{1}{2}$" square, into correct shape, in one impression, in a pair of dies. They were struck two blows with a heavy drop. Sections of the dies, top and bottom, are shown in Fig. 7. The blacksmith who dropped them was able to gauge the stock so closely that they did not form much fin. When this was trimmed off, the forging was completed by re-dropping them at a light heat.



Link Grinding Machine.

Link Grinding Machine.

The cuts shown herewith were made from the working drawings of a machine for grinding locomotive links and blocks true and to the proper radius after hardening.

After links are planed up true they are usually sprung, to some extent, in hardening, making it necessary to grind the space and block. When ground by hand in the usual way, the space and block are ground to work freely, but the true radius is always lost. With this machine any desired radius can be quickly ground true.

It consists of a frame carrying an arm, upon which is mounted an emery wheel; this arm is, by means of the worm and worm wheel shown beneath the table, given a swinging movement from side to side over a movable table or platen, upon which the work is fastened. This swinging motion is automatic, as is also the feed by which the emery wheel is moved up and down. There is a slide in the swinging arm by which it can be set at any desired radius, graduations upon the slide being provided for facilitating the operation. The machine is driven from an overhead countershaft not shown.

In operation, an annular wheel is first used, by which the sides of the link are ground true and parallel, and of equal thickness. Then the faces of the link saddle are ground true, and square with the saddle pin. The two parts of the link may now be bolted together, leaving out the end blocks so that the center of the grinding wheel can swing past the clearance spaces at the ends of the link. Then set the slide on the swinging arm by the graduations, so that the center of the grinder spindle will swing in the arc of a circle, the radius of which is equal to that of the link. The link is then adjusted on the platen of the machine so that the center line of its opening (or slot) will coincide with the center of the grinder spindle, after which the platen should not be moved while finishing the curved surfaces of the link, but all adjusting should be done by the swinging arm, the platen remaining stationary.

Now, using an emery wheel slightly smaller than the opening in the link, one of the curved surfaces may be ground, noting by the graduations on the arm the distance required to move the grinder beyond the fixed center line to finish the surface. Then when grinding the other surface, it should be finished at the same distance from the other side of the fixed center line; thus always working equal distances each way from the center line of the opening in the link.

The link block may be ground to fit by substantially the same methods, setting to the same radius and finishing at equal distances each way from the center line, as already explained.

It will be seen that this machine is adapted to perform in a superior manner work which has been at best little better than drudgery, and which is usually quite unsatisfactory when done.

The machine is the invention of Byron E. Parks, of Big Rapids, Mich., and is built by Pedrick & Ayer, Philadelphia, Pa.

Machine Designing.

By Prof. John E. Sweet.

A Lecture Delivered Before the Franklin Institute, and Reprinted, by Courtesy of the *Journal of the Franklin Institute*.

[Owing to the length of this lecture, and our limited space, we are obliged to divide it into three parts.]

Ladies and Gentlemen, Members of the Institute: "Carrying coals to Newcastle," the oft-quoted comparison, fittingly indicates the position I place myself in when attempting to address members of this Institute on the subject of machine designing.

Philadelphia, the birthplace of the great and nearly all the good work in this, the noblest of all industrial arts, needs no help or praise at my hands, but I hope her sons may be prevailed upon to do in their right way what I shall try to do roughly—that is, formulate some rules or establish principles by which we, who are not endowed with genius, may so gauge our work as to avoid doing that which is truly bad. No great author was ever made by studying grammar, rhetoric, language, history, or by imitating some other author, however great. Neither has there ever been any great poet or artist produced by training. But there are many writers who are not great authors, many rhymesters who are not poets, and many painters who are not artists; and while training will not make great men of them, it will help them to avoid doing that which is absolutely bad; and so may it not be with machine designing? If there are among you some who have a genius for it, what I shall have to say will do you no good, for genius needs no rules, no laws, no help, no training, and the sooner you let what I have to say pass from your minds, the better. Rules only hamper the man of genius, but for us who, either from choice or necessity, work away at machine designing without the gift, cannot some simple ruling facts be determined and rules formulated or principles laid down, by which we can determine what is really good, and what bad? One of the most important and one of the first things in the construction of a building is the foundation, and the laws which govern its construction can be stated in a breath, and ought to be understood by everyone. Assuming the ground upon which a building is to be built to be of uniform density, *the width* of the foundation should be in proportion to the load, the foundation should taper equally on each side, and the center of the foundation should be under the center of pressure. In other words, it is as fatal to success to have too much foundation under the light load as too little under a heavy one.

Cannot we analyze causes and effects, cost and requirements, so as to formulate some simple laws similar to the above, by which we shall be able to determine what is a good and what a bad arrangement of machinery, foundation, framing or supports? A vast amount of work is expended to make machines true, and the machines, or a large majority of them, are expected to produce true work of some kind in turn. Then, if this be admitted, cannot the following law be established—that every machine should be so designed and constructed that when once made true it will so remain, regardless of wear and all external influences to which it is liable to be subjected. One tool-maker says that is right, and another that it cannot be done. No matter whether it can or cannot, is it not the thing wanted, and if so, is it not an object worth striving for? One tool-maker says that all machine tools, engines and machinery should set on solid stone foundations. Should they? They do not always, for in substantial Philadelphia some machine tools used by machine builders stand upon second floors, or, perhaps, higher up; and of these machine tools none, or few at least, except those mounted upon a single pedestal, are free from detrimental torsion where the floor upon which they rest is distorted by unequal loading. But to first consider those of such magnitude as to render it absolutely necessary to erect them—not rest them—on masonry, is due consideration always taken to arrange an unequal foundation to support the unequal loads?—and they cannot be expected to remain true if not. When one has the good fortune to have a machine to design of such extent that the masonry becomes the main part of it, what part of the glory does he give to the mason? Is the masonry part of it always satisfactory, and is not this resorting to the mason for a frame rather than a support adopted on smaller machines than is necessary? Is it necessary even in a planing machine of forty feet length of bed and a thirty-foot table? Could not the bed be cast in three pieces—the center a rectangular box 5, or 6, or 7 feet square, 20 feet long, with internal end flanges, ways planed on its upper surface, and ends squared off—a monster perhaps, but if our civil engineers wanted such a casting for a bridge they'd get it. Add to this central section two bevel pieces of half the length, and set the whole down through the floor where your masonry would have been, and rest the whole on two cross walls, and you would have a structure that, if once made true, would remain so, regardless of external influences.

Cost? Yes; and so do Frodsham watches—more than "Waterbury." It may be claimed, in fact, I have seen lathes resting on six and eight feet, engines on ten, and a planing machine on a dozen. Do they remain true? Sometimes they do, and many times they do not. Is the principle right? Not when it can be avoided; and when it cannot be avoided, the true principle of foundation building should be employed. * * * A strange example of depending on the stone foundation for not simply support, but to resist strain, may be found in the machines used for beveling the edges of boiler plate. Not so particularly strange that the first one might have, like Topsy, "growed," but strange, because each builder copies the original. You will remember it, a complete machine set upon a stone foundation, to straighten and hold a plate, and another complete machine set down by the side of it and bolted to the same stone to plane off the edge; a lot of wasted material and a lot of wasted genius, it always seems to me. Going around Robin Hood's barn is the old comparison. Why not hook the tool carriage on the side of the clamping structure, and thus dispense with one of the frames altogether?

Many of the modern builders of what Chordal calls the Hyphen Corliss Engine claim to have made a great advance by putting a post under the center of the frame, but whether in acknowledgment that the frame would be likely to go down or the stonework come up I could never make out. What I should fear would be that the stone would come up and take the frame with it. Every brick mason knows better than to bed mortar under the center of a window sill; and this putting a prop under the center of an engine-girder seems a parallel case. They say Mr. Corliss would have done the same thing if he had thought of it. I do not believe it. If Mr. Corliss had found his frames too weak, he would soon have found a way to make them stronger.

John Richards, once a resident of this city, and likely the best designer of wood-working machinery this country, if not the world, ever saw, pointed out in some of his letters the true form for constructing machine framing, and in a way that it had never been forced on my mind before. As dozens, yes, hundreds, of new designs have been brought out by machine tool-makers and engine builders since John Richards made a convert of me, without any one else, so far as I know, having applied the principle in its broadest sense, I hope to present the case to you in a material form, in the hope that it may be more thoroughly appreciated.

The usual form of lathe and planer beds or frames is two side plates and a lot of cross girts; their duty is to guide the carriages or tables in straight lines and carry loads resisting bending and torsional strains. If a designer desires to make his lathe frame stronger than the other fellow's, he thinks, if he thinks at all, that he will put in more iron, rather than as he ought to think, how shall I distribute the iron so that it will do the most good?

In illustration of this peculiar way of doing things, which is not wholly confined to machine designers, I should like to relate a story, and as I had to carry the large end of the joke, it may do for me to tell it.

While occupying a prominent position, and yet compelled to carry my dinner, my wife thought the common dinner pail, with which you are probably familiar (by sight, of course), was not quite the thing for a professor (even by brevet) to be seen carrying through the streets. So she interviewed the tinsmith to see if he could not get up something a little more tony than the regulation fifty-cent sort. Oh, yes, he could do that very nicely. How much would the best one he could make cost? Well, if she could stand the racket he could make one worth a dollar. She thought she could, and the pail was ordered, and made and delivered with pride. Perhaps you can guess the result. A *fac-simile* of the original, only twice the size.

Now, this is a very fair illustration of the fallacy of making things stronger by simply adding iron. To illustrate what I think a much better way, I have had made these crude models (see Fig 1), for the full force of which, as I said before, I am indebted to John Richards; and I would here add that the mechanic who has never learned anything from John Richards is either a very good or very poor one, or has never read what John Richards has written or heard what he has had to say.

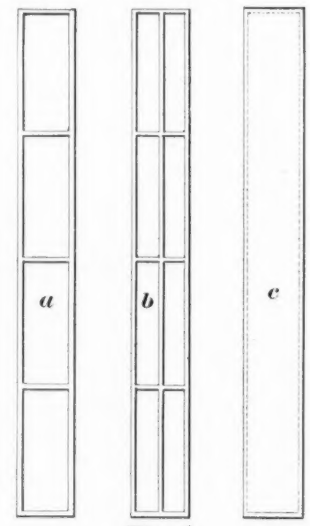


Fig. 1.

Three models, as shown in Fig. 1, were exhibited; all were of the same general dimensions and containing the same amount of material. The one made on the box principle *c*, proved to be fifty per cent. stiffer in a vertical direction than either *a* or *b*, from twenty to fifty times stiffer sidewise, and thirteen times more rigid against torsion than either of the others.

However strong a frame may be, its own weight, and the weight of the work upon it, tends to spring it unless evenly distributed, and to twist it unless evenly proportioned. For all small machines the single post obviates all trouble, but for machine tools of from twice to a half dozen times their own length the single post is not available. Four legs are used for machines up to ten feet or so, and above that legs various and then solid masonry. If the four legs are always set upon solid masonry, and leveled perfectly when set, no question could be raised against the usual arrangement, unless it be this: Ought they not to be set nearly one-fourth the way from the end of the bed? Or, to put it in another form: Will not the bed of an iron planing machine twelve feet in length be equally as well supported by four legs if each pair is set three feet from the ends—that is, six feet apart—as by six legs, two pair at the ends and one in the center, and the pairs six feet apart? There being six feet of unsupported bed in either case, with this advantage in favor of the four over the six, settling of the foundation would not bend the bed.

It is not likely that one-half of the four-legged machine tools used in this country are resting upon stable foundations, nor that they ever will be; and while this is a fact, it must also remain a fact that they should be built so as to do their best on an unstable one. Any one of the thousand iron planing machines of the country, if put in good condition and set up on the ordinary wood floors, may be made to plane work winding in either direction by shifting a moving load of a few hundred pounds on the floor from one corner of the machine to the other, and the ways of the ordinary turning lathe may be more easily distorted still. Machine-tool builders do not believe this simply because they have not tried it. That is, I suppose this must be so, for the proof is so positive, and the remedy so simple, that it does not seem possible they can know the fact and overlook it. The remedy in the case of the planer is to rest the structure on the two housings at the rear end and on a pair of legs about one-fourth of the way back from the front, pivoted to the bed on a single bolt as near the top as possible.

A similar arrangement applies to the lathe and machine tools of that character—that is, machines of considerable length in proportion to their width, and with beds made sufficiently strong within themselves to resist all bending and torsional strains, fill the requirements so far as all except wear is concerned; that is, if the frames are once made true they will remain so regardless of all external influence that can be reasonably anticipated.

Among wood-working machines there are many that cannot be built on the single rectangular box plan—rested on three points of support. Fortunately the requirements are not such as demand absolute straight and flat work, because, in part from the fact that the material dealt with will not remain straight and flat even if once made so; and in the design of wood-working machinery it is of more importance to so design that one section or element shall remain true within itself, than that the various elements should remain true with one another.

The lathe, the planing machine, the drilling machine, and many other of the now standard machine tools will never be superseded, and will for a long time to come remain subjects of alteration and attempted improvement in every detail. The headstock of a lathe—the back gear in particular—is about as hard a thing to improve as the link motion of a locomotive.

Some arrangement by which a single motion would change from fast to slow, and a substitute for the flanges on the pulleys, which are intended to keep the belt out of the gear, but never do, might be improvements. If the flanges were cast on the headstock itself, and stand still, rather than on the pulley, where they keep turning, the belt would keep out from between the gear for a certainty. One motion should fasten a footstock, and as secure as it is possible to secure it, and a single motion free it so it could be moved from end to end of the bed. The reason any lathe takes more than a single motion is because of elasticity in the parts, imperfection in the planing, and from another cause infinitely greater than the others, the swinging of the hold-down bolts.

Should not the propelling powers of a lathe slide be as near the point of greatest resistance as possible, as is the case in a Sellers lathe, and the guiding ways as close to the greatest resistance and propelling power as possible, and all other necessary guiding surfaces made to run as free as possible?

A common expression to be found among the descriptions of new lathes is the one that says "the carriage has a long bearing on the ways." Long is a relative word, and the only place I have seen any long slides among the lathes in the market is in the advertisements.

But if any one has the courage to make a long one they will need something beside material to make a success of it. It needs only that the guiding side should be long, and that must be as rigid as possible—nothing short of casting the apron in the same piece will be strong enough, because with a long, elastic guide heavy work will spring it down and wear it away at the center, and then with light work it will ride at the ends with a chattering cut as a consequence.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SIXTY-THIRD PAPER.

Counterbalance, continued.

Figs. 388 and 389 represent the form of one of the cast-iron segments of a counterbalance designed to be bolted between the spokes. As will be seen, this segment is made in two pieces, *A* and *B*. The piece *A* is placed in the outer face of the driving wheel, and *B* in the inner face of the wheel. They are held together and clamped to the wheel by the three bolts *c*, *c*, c_2. In large wheels these bolts are $\frac{7}{8}$ of an inch diameter; in small wheels $\frac{5}{8}$ inch diameter. Since the space through which the counterbalance has to move is nearly always limited, the bolt heads are generally made conical and countersunk into the outer piece *A*; in the inner piece *B*, pockets *f* are cast to receive the nuts. The strips *g*, *g*, are simply chipping strips, so that the weights can be snugly fitted between the spokes and rim.

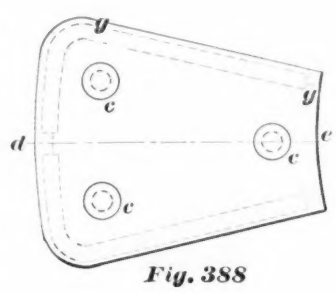


Fig. 388

Fig. 389

The thickness of the outer piece *A* depends upon the available space through which—in connection with the axle—it can revolve. In some cases, the thickness of the same piece depends upon the amount of weight required. The inner piece *B* is usually kept even with the spokes. The length *d e* also depends upon the amount of weight required, and varies from about one-half to three-quarters of the distance between the rim and hub of the wheel. These segments should never fill the whole space from rim to hub, because, if these spaces are closed by the segments, it will, when the wheels are in certain position, be very difficult to oil the axle journals.

In calculating the weight of the counterbalance it is always best to establish first the length *d e* of the segment, and then find its thickness.

Practical Example.—It is required to find the dimensions of the segments of a counterbalance for an eight-wheeled locomotive—that is, an engine having four driving wheels and a four-wheeled truck, such as is shown in Fig. 1. Cylinders, 18 inches in diameter; stroke, 24 inches; weight of crosshead, 154 pounds; piston and rod, complete, 306 pounds; main rod, 280 pounds; side rod, 240 pounds; crank-pin, 60 pounds. The form of wheel is shown in Fig. 390.

Not only the revolving parts, but also the reciprocating parts of a locomotive will have a disturbing influence on the smooth forward and backward motion of the engine. To obtain a steady motion the weight of all the parts which produce a disturbing influence must be counterbalanced. Engineers agree that the sum of the weights of all the revolving parts must be counterbalaneed; but as to the amount of weight of the reciprocating parts, which ought to be counterbalanced, engineers are not unanimous. A few believe that only two-thirds of the weight of the reciprocating parts should be counterbalanced. Our practice has been to counterbalance the sum of the weights of all the reciprocating parts, and we believe it is safe to say that this is the practice of the majority of engineers, and will give the best results; we will follow this practice in the example under consideration.

In determining the dimensions of the counterbalance we need to confine our attention to only one side of the engine, and consequently in our calculation we have to deal with only two driving wheels through which the counterbalace must be distributed. Each wheel should have enough weight to counterbalance one-half of the weight of the reciprocating parts, in addition to the total weight of the parts which revolve with the wheel. Hence our first step will be to separate the weights of the revolving and the reciprocating parts.

The parts, and their weights, which revolve with the main driving wheel, are:

Crank-pin	60 lbs.
Weight of crank referred to pin.	180 "
One-half side rod	120 "
One-half main rod	140 "
Total weight of the revolving parts	500 "

The parts, and their weights, which revolve with the rear driving wheel are:

Crank-pin	60 lbs.
Weight of crank referred to pin.	180 "
One-half of side rod	120 "
Total weight of revolving parts.	360 "

By the term weight of the crank referred to the crank-pin is meant that weight which, when applied to the crank-pin, will have the same effect in tending to turn the axle as the whole of the weight of the crank applied to the center of gravity of the crank, as explained in fifty-ninth paper. To find the weight of the crank referred to the crank-pin, we must first find the center of gravity of the crank by the method shown in Fig. 377, and then compute the weight by Rule 40. Of course, in this case, the thickness of the crank is supposed to be uniform. When the thickness is not uniform another method is often adopted, which will be explained at the end of this paper.

Reciprocating parts, and their weights, are:

Crosshead, pin, etc	154 lbs.
Piston and rod	306 "
One-half of main rod	140 "
Total weight of reciprocating parts	600 "

One-half of this weight must be counterbalanced in the main wheel, the other half in the rear wheel. Consequently, the total weight to be counterbalanced in the main driving wheel will be

$$500 + 300 = 800 \text{ pounds};$$

and the weight to be counterbalanced in the rear driving wheel will be

$$360 + 300 = 660 \text{ pounds}.$$

We will first determine the dimensions of the segments composing the counterbalance in the main driving wheel. In this wheel we have to counterbalance 800 pounds applied to the crank-pin, and since the distance between the center of crank-pin and center of axle is twelve inches, the moment of the force produced by the 800 pounds is

$$800 \times 12 = 9{,}600.$$

(See 59th paper.)

Our next step will be to establish the number of segments in the counterbalance, and also the length *d e* of each. No regular rules for determining the number of segments, and their lengths, can be given. An experienced engineer will readily see that four segments *A*, *B*, *D* and *E* (Fig. 390), will be necessary. A smaller number of segments would make their thicknesses too great for the available space through which they have to move. Hence we will decide that four segments are to be used, and that the length *d e* of each one is to be twelve inches.

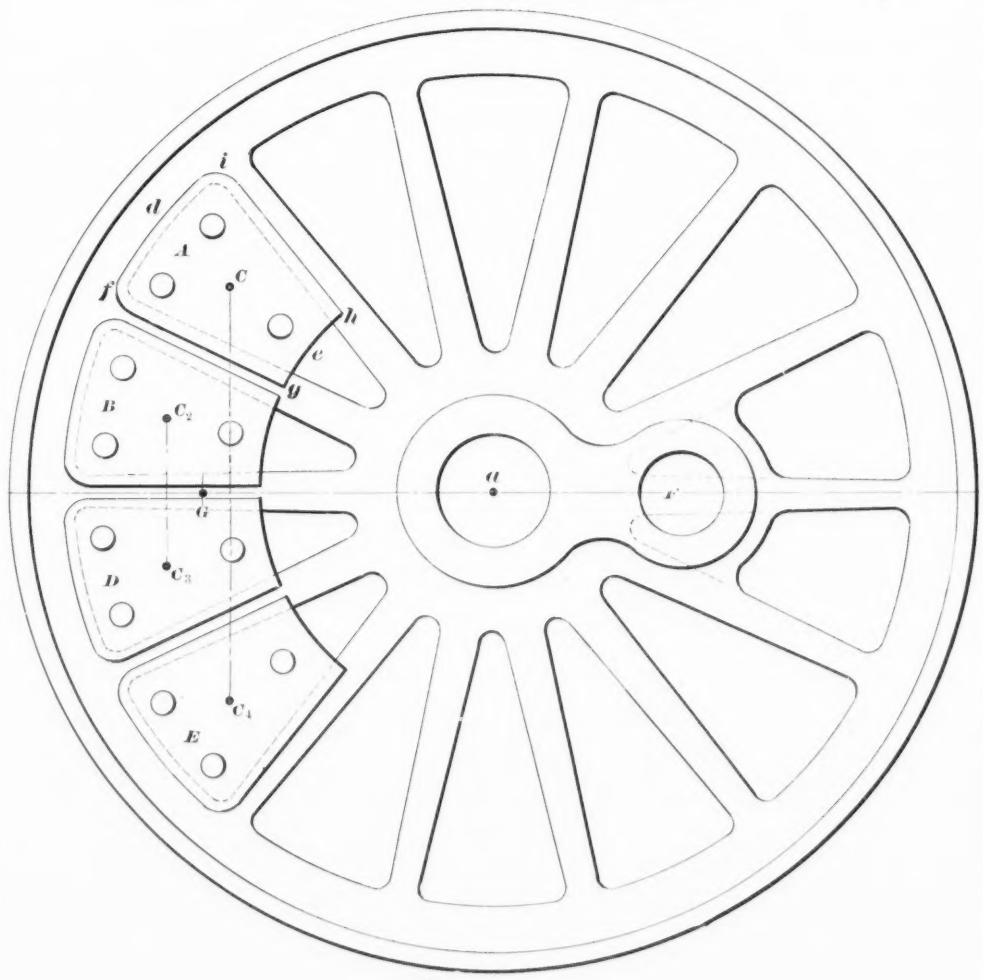


Fig. 390

We now find the center of gravity *C* of one of the segments in a manner as shown in Fig. 374 or 378, and then find the common center of gravity *G* of the four segments by the method shown in Fig. 383 and explained in the 62d paper. Measuring the distance between the common center of gravity *G* and the center *a* of the axle, Fig. 390, we find it to be $18\frac{3}{4}$ inches. Now, since the moment of force produced by the weight of the four segments, that is, the product obtained by multiplying the total weight of the four segments by the $18\frac{3}{4}$ inches, must be equal to the moment of the force produced by weight applied to the crank-pin, namely 9,€00 (previously determined), we can find the total weight of the four segments by Rule 41. Hence we have

$$\frac{800 \times 12}{18.75} = \frac{9{,}600}{18.75} = 512 \text{ pounds}.$$

Since the weight of a cubic inch of cast-iron is .26 of a pound, the total number of cubic inches in the four segments will be, according to Rule 42,

$$\frac{512}{.26} = 1{,}969 \text{ cubic inches}.$$

Assuming that in Fig. 390 the area of *f g h i* of one segment is 80 square inches, then the area of the four segments will be

$$80 \times 4 = 320 \text{ square inches}.$$

And lastly the thickness of the counterbalance, or, which amounts to the same thing, the thickness of each segment, will be, according to Rule 43,

$$\frac{1{,}969}{320} = 6.15+ \text{inches}.$$

The dimensions of the segments for the rear driving wheel are found in a manner precisely similar to the foregoing, that is, we first establish the length *d e* of the segments, and then find the thickness. We will make the calculations without explanatory remarks.

Let us decide that the length *d e* of each one of the four segments in the rear driving wheel is to be 12 inches, that is, equal to the length of segments in the main driving wheel.

Under these conditions the common center of gravity *G* will be $18\frac{3}{4}$ inches from the center *a* of the axle, the same as in the main driving wheel. Now remembering that the total weight applied to the crank-pin in this wheel, and which must be counterbalanced, is 660 pounds, we have,

$$\frac{660 \times 12}{18.75} = 422.4 \text{ pounds},$$

which is the total number of pounds in the four segments. Again,

$$\frac{422.4}{.26} = 1{,}624 \text{ cubic inches}$$

in the four segments, and lastly,

$$\frac{1{,}624}{320} = 5 \text{ inches},$$

which is the thickness of each segment in the rear driving wheel.

It must be remarked here, that when the center of gravity *C* of one of the segments is to be found by the method shown in Fig. 378, the templet must be cut somewhat smaller than the face *f g h i* of the segment (Fig. 390) to allow for the amount of metal cut out of the segment for the spokes and rim. The reduction in the size of templet should be made in the length *d e*, bringing the arc *f i* closer to the arc *g h*; the reduction should be made at the end *f i*, none at *g h*, because the end *g h* has not to fit any part of the wheel, and consequently there is not any metal cut out at this end. A small reduction should also be made in the width, bringing the two sides *f g* and *h i* closer together. The amount of reduction is generally governed by good judgment, rather than by calculation, as the latter method is tedious and involves considerable labor. Any slight inaccuracy which may result can easily be corrected by finding the center of gravity of the pattern of the segment when made, which will enable us to correct any small error in the weight of the counterbalance by readjusting the common center of gravity *G* of all the segments, and make such slight changes in the pattern as may be deemed necessary. In many cases the required reduction of the templet will be so small that for practical purposes we may cut the templet to conform to the surface *f g h i* without making any reduction. The same remarks also apply to

the method of finding the center of gravity C shown in Fig. 374.

It must also be noticed that the weight of the counterbalance, found in the manner as we have done, will be slightly—very slightly—too heavy, for the following reason:

If the wheel center is made without the crank-pin hub, and if the workmanship is absolutely perfect, the wheel center itself will be perfectly balanced. In putting in the crank-pin hub, a portion F of the spokes must be cut out, and for this amount of metal thus cut out, no allowance has been made, and consequently the counterbalance is not only sufficient for the weight of the crank, but also for the amount F cut out of the spokes, and therefore the counterbalance is slightly too heavy, but by an amount barely appreciable.

Again, engineers and draftsmen often find it difficult to determine the exact location of the center of gravity of the crank, and therefore, instead of finding the weight of the crank referred to the crank-pin, content themselves, by finding the weight of the crank-pin hub, that is, the weight of the metal around the crank-pin as indicated by the shaded portion in Fig. 391, and then adding this weight of the hub to the revolving parts to be counterbalaneed, in place of the weight of the crank referred to the crank-pin; by this method the necessity of finding the center of gravity of the crank is avoided.

This method of adding the weight of the crank-pin hub to the revolving parts, which must be counterbalanced, saves considerable labor in all cases, and is usually adopted when the crank is not of uniform thickness.

Shop Notes.

By Jarno.

No. 7.

ACCURATE LEVELS.

The body, or frame, of the level, Fig. 1, can be of cast-iron. The vial can be obtained from a maker of engineer's levels. There are two threaded holes in the upper part of the frame. Through these holes are put the screws that hold the vial. Upon the screws are nuts that clamp the lugs at the ends of the vial; by these nuts it can also be adjusted.

Vials of various degrees of accuracy are advertised. It is asserted that the most accurate ones will indicate a variation of one second of arc. This is less than .0002 inch in three feet, or less than one five-thousandths of an inch in thirty-six inches. I think a vial that will show when anything is out of level .001 inch in thirty-six inches, is accurate enough for machine shop purposes. If the level is too sensitive, the time taken to adjust anything by it is not paid for by the accuracy that is obtained.

At the works of Messrs. Bement & Miles, in Philadelphia, Mr. Frank Bement kindly showed me several levels made upon the same principle as Fig. 1. One of these levels had a frame like Fig. 2, and the vial was attached upon the upper side of the frame, and not in the middle, as in Fig. 1. The frame was of steel, hardened, and ground straight Through it were made the large holes, so that it should not be too heavy. These holes were of such diameter and at such a distance apart that the stock upon either side of any hole was of the same thickness as the stock upon the opposite side of the hole. This is to prevent the frame from crooking by unequal expansion from heat.

It is a sign of progress when the refinement of an engineer's level is brought into a machine shop. I think that, sometime, these levels will be made for the market.

Next Meeting of the Mechanical Engineers.

Secretary Hutton has issued a circular to the members, relating to the Nashville meeting of the American Society of Mechanical Engineers. The society will convene at Nashville, Tenn., on Tuesday, May 8, at 8 o'clock P. M., and will adjourn on Friday of the same week. The headquarters and secretary's office will be at the Maxwell House. Special railroad rates have been obtained. A large number of papers will be presented at this meeting, and the list of topical questions is large.

Design, Construction, Repairs and Management of Marine Steam Engines and Boilers.

By W. H. Hoffman.

FOURTH PAPER.

Perhaps I should have said in my first paper that I generally calculate the journal pressure from gauge figures, as this can be made constant, while we are not always certain of the amount of actual absolute pressure if we calculate the low pressure cylinder. For instance, our absolute pressure should be 174$\frac{7}{10}$ lbs., but undue condenser pressure may reduce this pressure, in varying amounts, owing to improper design, construction or management. In these calculations as to the initial pressure on the piston, I have deducted nothing for back pressure between the cylinders. The engine that we are proportioning has, we will say, a high pressure piston containing 530 square inches. As we have said before, our gauge pressure is 160 lbs., 175 lbs. absolute.

In practice we shall have an initial back pressure of about 70 lbs., leaving us an effective initial pressure of 105 lbs. to 110 lbs. per square inch. It will be seen that these conditions greatly relieve the stress and wear, on each of the journals, and leave us a large margin of bearing surface, even after adding the weight of the shaft, and the reciprocating parts resting on the shaft bearings, as this pressure relief follows on through all the crank bearings.

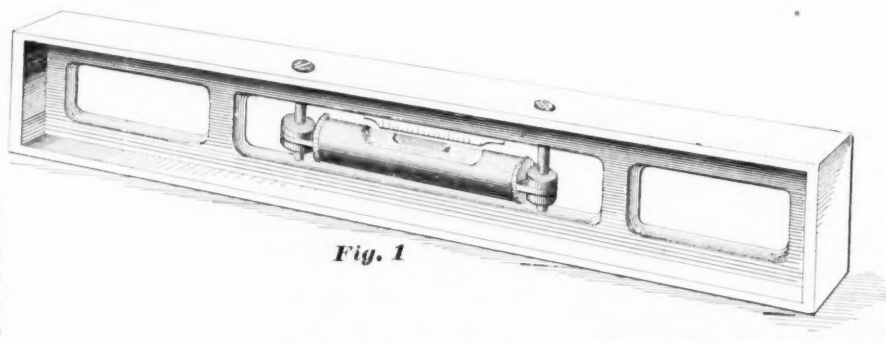


Fig. 1

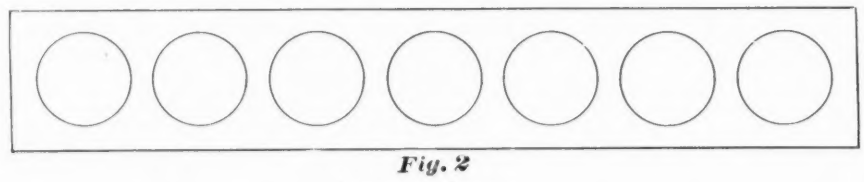


Fig. 2

ACCURATE LEVELS.

No other design or method of steam and pressure distribution can equal the modern triple expansion engine, and by this system enormous pressures can be carried without overheating the pins and journals, or producing extra torsion on the main shafts.

In former papers I have stated that practice is somewhat removed from theory, in the action of steam or heat in a condensing or low pressure cylinder. Theory says the terminal pressure in this cylinder shall not be much above four lbs. absolute; practice shows us that the most economical absolute terminal is about eight lbs., with usually a two lb. back pressure in the condenser. Theory also says that the vacuum should be 28½ inches, but practice teaches us that from 24 to 26 inches will give us the best results. Again, theory says, keep the hot well at 100°, and again practice leads us to raise this temperature to at least 120°, and 126° is now common practice.

The economy in the low pressure cylinder is largely due to keeping its walls as hot as possible. Supposing the entering steam to the low pressure cylinder has an absolute pressure of 24 lbs., and a temperature of 237°. We then release the steam at eight lbs. absolute, and our temperature has fallen to 183°, a variation of 54°. Had the release been a four lbs. absolute, the temperature would have been 153°, a variation of 84°. It is the great fluctuation of cylinder tempera tures that causes excessive cylinder condensation, the chief loss of power in a steam engine, and if those who formerly contended that they could obtain the same economy with fourteen to twenty expansions in a simple single cylinder engine had begun their figures at the condenser, I think they would have soon discovered their mistake. That is the cold end. Their idea was to admit steam at 175 lbs. absolute pressure, and discharge it at four lbs. absolute, in one cylinder. Their initial temperature would be 370°, and their releasing temperature, actual 153°, a variation of 217°.

All this teaches us that we cannot, with economy in view, make a condenser of the low pressure cylinder, but we must aim to keep up its temperature, and thereby bring the cylinder condensation here to a minimum line. Consequently it is not strange that the best results are obtained on what would appear to be a high mean effective pressure in the low pressure cylinder, or coming down to actual figures, to a pressure of 13 to 17 lbs. per square inch. In our example we will base our calculation on a mean effective pressure in the low pressure cylinder, of 14 lbs., and never less. I am aware that these figures are twenty-five per cent. higher than the old established practice, and I am also aware that with this practice this cylinder rarely did its share of the work. They figured on 11 lbs., and actually got eight lbs. The new pressure compels this cylinder to take its full measure of the load, as the calculated and actual mean effective pressures will agree very closely.

When the triple expansion engine first came into use the designers started with a low pressure cylinder of the same diameter as that of a two cylinder compound of the same power. Since that time practice has taught us that this diameter can be advantageously reduced. If the idle expansion is looked after in a compound engine, we have at once a large margin of heat to work on, and in this one item we have one of the chief causes of the great success of the well-designed triple expansion engine. The old two cylinder compound engine had one heat trap; the triple expansion engine has two. We develop, or should develop, two-thirds of our total power in two cylinders entirely separated from the condenser or cooling apparatus. The fluctuation of temperature in the high pressure cylinder is from 370° to about 314°, or a variation of 56°, and in the intermediate cylinder our variation will be from 55° to 63° or thereabouts. So it will be seen that with a variation of a little over 110°, we have produced two-thirds of our energy.

In the low pressure cylinder the fluctuation in the steam temperature will be from 54° to 60° instead of 217°, the latter variation being the amount due to the application of the single simple condensing cylinder, working with the same initial absolute steam pressure, and cutting off short enough for a terminal pressure of four lbs.

Using the gauge or boiler pressure to calculate bearing or journal pressure, we have a rule that answers for condensing and non-condensing engines alike. In the case of the non-condensing engine we have the actual pressure on the pins and journals, supposing that we reach the line of the atmosphere with our exhaust, and deducting no back pressure. In the case of the compound engine, double or triple, we are favored by our initial and terminal back pressures, on all pistons. With the plain single cylinder condensing engine, exhausting to within two or three lbs. of the absolute line, we increase our journal pressure slightly, but our factor of 400 lbs. per square inch allows us a liberal margin against the liability of undue heat. I think it quite probable that most of our practical marine engineers fully understand that high initial steam means economy, and I also think that the reading, thoughtful men among these very useful members of the fraternity are thoroughly aware that the results obtained in the triple expansion engine trials cannot possibly be reached by any other system having a fewer number of cylinders. These engineers also know that the addition of 20 lbs. to the gauge pressure (180 lbs. or 195 lbs. absolute) and an extra steam cylinder giving us a quadruple system, has made a decided saving over the triple system. There have been many experiments made with the quadruple engine during the year 1887, and up to date, that have shown astonishing results in the way of economy of fuel, and there are parties here, and abroad, who are willing to guarantee a practical working duty of 1¼ lbs. of coal per horse power per hour, developing 500 horse power and upwards. This was considered an impossibility five years ago, and ten or twelve years ago, long after the general adoption of the compound (two cylinder) system by most of the European lines we found plenty of builders and engineers here, who, in emphatic terms, pronounced the whole compound system a humbug. There has been a large quantity of "crow" eaten since then. Those unfriendly to the advancement of the expansive system raised the question of repairs. They said: "If there should, by 'hook or by crook,' be a little saving, ('purely accidental, you know'), this little saving will be instantly wiped out by the enormous repairs made necessary by the use of the extra cylinders. As a matter of fact, the repairs on a well-designed and well-built triple expansion engine are much less in twelve months running, than they were formerly on single cylinder condensing engines of the same power. A three cylinder, three crank engine rarely breaks a crank shaft, and if fairly well fitted up will never heat the main boxes to a troublesome degree. By this design the piston area can be reduced in proportion to the saving or trapping of the heat.

Having three cranks placed at 120°, the revolutions can be increased, giving high piston speed, as the strokes can be long, owing to the equipoise of the reciprocating parts. The torsion on the whole line of shafting is greatly reduced, and the high speed imparted to the shaft enables us to reduce its diameter, and consequently its weight.

In the construction of the modern triple expansion engine, the prominent builders make the piston rods, crossheads, connecting rods, and a large portion of the valve gear for each cylinder, exactly the same in every particular, thus introducing the interchangeable system in all the main parts of transmission. The high pressure piston rod is made a little larger than the usual requirement by formula, and by so doing, it is brought to a size suitable to the diameter of the low pressure piston, considering the general appearance, though this is by no means necessary for the sake of tensile or compressive strength.

In proportioning the details of our engine, we shall follow the interchangeable plan in every possible way, for several reasons. First, for convenience in case of breakage; next, additional strength; and last, on account of the great simplicity in design and cheapness of construction. All these improvements have been brought about by the introduction and successful development of the high grade expansive marine engine. After years and years of steam engine building it was left for the marine engine designers to

produce a steam motor that would develop an indicated horse-power with less than 1½ lbs. of coal per hour. The stationary engine builders were for years trying to "get there" with automatic cut-offs, etc., but the marine man slipped in the third cylinder, and sailed off with the prize, and if the signs of times are correct this "sailor man" is liable to keep it for some time.

LETTERS FROM PRACTICAL MEN.

Gascon's Planer.

Editor American Machinist:

"Jarno," in "Shop Notes, No. 5," tells us a little about Gascon's experience with a planer out of level. I fail to see any need for a planer to be absolutely or even approximately level. Had Gascon's planer man used a surface gauge, as he should have done in setting the machine beds, the shaft holes would have come nearer the center of the bosses than they did. A solid foundation is a grand thing for a planer; but few, however, get one.

Sometimes a planer plate becomes "pened" in the middle of its length, and then for long work a surface gauge is not reliable unless it be used from the crosshead instead of from the platen. I hope Gascon pays as much attention to having the crosshead elevating screws of the same pitch as he does to having a good foundation.

F. L. Johnson.

Softening Cast-Iron—Milling vs. Planing.

Editor American Machinist:

Much has been said lately about hardening cast-iron. During the years of my experience I have never had any occasion to harden cast-iron, but have frequently wanted to soften it. If any of your readers or writers have a good, easy and reliable method of softening cast-iron which is too hard to drill or turn, no doubt many other readers would like to know of it. I have seen many methods tried, but what is wanted is one that is easy and reliable.

In the controversy on "Milling *vs.* Planing" it should not be overlooked that the width of the work is an important factor. Under three inches in width I have no doubt that the planer or shaper is much the quicker. Having some gibs and keys to finish, I first took a cut over them in the shaper, two at a time. A milling cut took twice as long, and the shaper could have taken twice the length of stroke at a revolution and not cut too fast—which would have been equivalent to four times the surface the milling machine would do at that width—under three inches.

As far as my experience and observation goes on keyways in shafting, give me a good stiff planer with tools to my motion, and the other man can take the stiffest milling machine made, and I would feel confident of beating him two to one at the very least, including the drilling of holes to step in and finishing out the starting point with the chisel when necessary, except, perhaps, very short keyways in from the ends. The milling machine, properly handled, does nice work, and I like it, but still for some things that it will do, a planer will do just as well, and quicker, cheaper and easier.

Center Punch.

He Couldn't Wait.

Editor American Machinist:

Smith runs a small shop on any small tools or hardware specialties he can get to make. I called on him the other day, and found him all out of sorts. He stood glaring at a pile of small rough castings, just received from a new foundry. He had been in a hurry, as the job was wanted at once, and had concluded to try another foundry on castings, as he couldn't wait on the slow motions of Snap's foundry any longer. He took his wood patterns to another foundry, where they claimed to get out first-class work at short notice and low prices. They had warped his patterns almost beyond recognition; had hacked up the edges with rammers, filed down the core-boxes; soaked most of the letters off; hadn't cleaned the castings; charged two prices, and not got out full sets of any one piece. So Smith was mad. He said he had tried nearly every foundry in town to get good work promptly, and every time he was in a hurry something of this sort was sure to happen. He had lost money and very likely one of his best customers. Now he is obliged to go back to Snap's after all and wait till his turn comes, for Snap's foundry makes a specialty of his kind of work. The fact is, Smith has found that a foundry fitted up for heavy castings is not suited to his class of work.

I wanted some $\frac{1}{16}$" holes drilled in a piece of casting. Smith took the job out and gave it to the boy that runs the roughout lathe, as all the drill presses were busy, and told him to put on the chuck and grab the $\frac{1}{16}$" drill in it, and drill the holes, and to hurry up, as I was waiting. The boy took out the back center and fed the job by the tail screw; he drilled the holes all right, but now there is a $\frac{1}{16}$" hole in the spindle where the back center used to be. When I went away Smith was explaining to the boy how he could have done that job without ruining the lathe, and the man on the big drill press asked him what he wanted drilled next, as he had finished his job.

Mr. Editor, the circumstances narrated above are dead true; I confess to changing the names. Traveler.

How to Become a Locomotive Engineer.

Editor American Machinist:

Engineers are not made to order. No doubt you have read "How to Become an Actor," or how to become this or that, but you wish to be an engineer. Well, first go into the shops of some railroad company and serve an apprenticeship at the machinist trade. You will be after knowledge, and willing to work hard. You will be paid about seventy cents per day in money, the remainder in knowledge. If you are an apt pupil, and work earnestly, your pay will gradually be raised, so that when you begin the third year you will be drawing the princely salary of ninety cents per day. You will still be drawing part of your compensation in knowledge, however.

After you have paid for boarding and clothes you can spend the remainder of your salary in buying books that treat on mechanics, wherein you can read many things that you ought to know, if you could only understand them, and some other things that you ought never know. Well, after serving the apprenticeship you can go out on the road to fire extra, and when your turn comes, in a week, or in two years, as the case may be, you will get a regular engine to fire. Now the soft snap begins, if it has not begun already. You will only be required to keep the engine clean, hot, keep off the rust in bad weather, fill oil cans, clean fires, carry sawdust, draw supplies, put out and take in signals, put in a little bit of packing in piston or valve stem box, when the engineer has some pressing business up street and tells you to do it, if you happen around (you always happen around in such cases). You will do all this and various other jobs; also be told occasionally that you are no good, and cannot fire a cook stove. However, if you have perseverance, and do your duty manfully for four or five years, you may eventually get killed or promoted. Become an engineer? Oh, no; not yet. You are not an engineer yet. You have one year ahead of you wherein you will have to tax your judgment and skill to the utmost limit in order to get through safely. With breakdowns, narrow escapes, and blunders, etc., you will put in the most memorable year of your life learning to become a locomotive engineer.

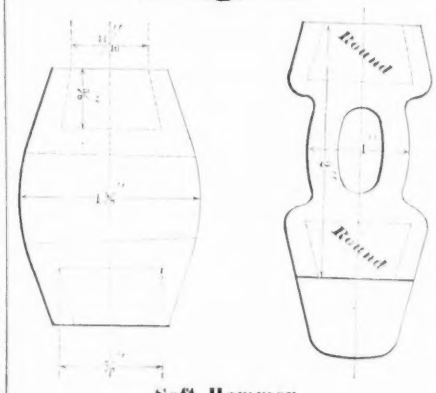
If you pull through all right, and run on for two or three years, meanwhile read up on matters bearing directly and indirectly on the calling you follow, acquire habits of thought and observation, you may eventually become a first-class locomotive engineer. But if you have not a natural liking and inclination for the business and hard work, you better stay away; there are too many "middling" engineers now. J. J. Clair.

Pittsburgh, Pa.

Mrs. Belle Lawson, Scottville, Ky., is desirous of learning the whereabouts of her husband, Charles G. Lawson. Mr. Lawson is a machinist and engineer, and Mrs. Lawson thinks a notice of this kind will reach him, from the fact that he always read the American Machinist. She has not heard from him since Oct. 17, 1887. We trust this notice will serve the desired purpose.

It has been assumed that a lightning rod protects a certain area, depending upon the altitude of the point over the surrounding objects, and that, as far as the conductor is concerned, a low resistance and a good earth are the most important, and perhaps the only important consideration.

The investigations of Professor Oliver J. Lodge, which he brought before the Society of Arts (England), in the Mann lectures delivered on the 10th and 17th of March, would seem to indicate that these elementary notions are not correct. From his experiments it appears that absolute immunity from the danger of lightning is not attainable, but that we may minimize the danger, not by the employment of high lightning rods and a few stout conductors, but by fitting the eaves and roofs of buildings with barbed wire, and connecting the wire in a great number of places with the earth by iron wires of comparatively small section.



Soft Hammer.

The sketch—about half-size—illustrates the plan adopted by J. W. Hawkins, superintendent of the works of the Railway Speed Recorder Co., of Kent, Ohio, for making soft hammers for use in the works. The body of the hammer, which of course can be made of any weight desired, is of cast-iron, cast with reverse taper holes in the ends. Then a metal cup is placed over the ends, with a hole through it, and soft metal—as tin—is poured in, the inside of the cup giving it the form as shown in the engraving.

Shop Notes.

During a recent visit to the shops of Hartford we found them in good shape as regards business and prospects, and the outlook for the machine tool and other industries there seems good. The Pratt & Whitney Co. have just completed a new brick warehouse, in which they intend to try to accumulate and keep a stock of their tools, from which orders may be filled. It is a first-class building of four stories and basement, with 9,000 square feet of floor space in each story. The floors are very strong and well supported, and the ceilings fitted with overhead rails, on which trolleys run, carrying hand hoists for moving machinery about the floors.

The trucks on which finished machines are brought from the shops are driven into a place within the building where the platform comes level with the lower floor, and from this place the machines can be taken by the hoists and trolleys, in connection with a large and powerful elevator, to any position upon either floor, with very little handling. Each floor is provided with overhead water pipes, having automatic sprinklers for fire protection. The elevator is run by an electric motor. The basement is connected with the shops by an underground passageway across the street. The building, with its equipment, has cost about $40,000.

Part of one of the floors is at present used as a shop, in which they are building for other parties a type-setting, justifying and distributing machine, which, when completed, will probably be one of the most complicated and ingenious machines ever constructed.

The P. & W. Co. have just completed the contract for 250 machine guns which they made for the Italian Government, and are now getting ready for making the Hotchkiss machine guns on a large scale. Mr. Parkhurst, who has this department in charge, went to England and France and saw their methods for doing similar work there, and as a result is very well satisfied with his own equipment and tools, believing, as he does, that they are far superior. The requirements of this work, in point of accuracy, interchangeability, etc., are very exacting, and the tools and fixtures, to do the work satisfactorily, must be of the best. Their system of boring for barrels is especially ingenious, and is the outgrowth of their experience in boring the numerous hollow spindles used upon their machine tools. The drill which does the work has been described in these columns, together with a statement as to its efficiency. The holes bored by it are remarkably true, smooth, straight, and accurate to gauge.

The keys, or feathers, used about the gun are made solid with the stud, instead of being inserted, as is done on ordinary work. This makes it necessary to mill that part of the stud instead of turning it, and as the piece must be accurately interchangeable there is considerable labor involved. This is a feature which, fortunately or otherwise, is not much considered by army officers, however.

Some peculiar jobs of broaching are also done on the gun. One piece consists of a small sleeve, having an arm or lever about four inches long forged on it. A round hole extends nearly through the piece, and terminates in a peculiar-shaped hole, which must be broached quite accurately. They do the job by the use of a circular plate of cast-iron about twelve inches in diameter, in the center of which is a vertical steel stud, which fits the hole in the sleeve. This stud has a square slot, like a key seat, in one side of it, which extends from the top down through the plate. Into this slot the broaches are fitted. Only one side of the broaches have teeth, the others being smooth. Around the outer edge of the plate there are a number of projections cast on, the tops of which are planed out to receive the end of the lever, which is forged onto the sleeve, and into which it can be fastened by a set screw. There are as many of these places as there are sides to the hole which is to be broached, and the lever is fastened into one after another of them, while the proper broaches for the corresponding side of the hole are forced through the slot in the stud. As this slot, and the several positions in which the lever is fastened, bear a fixed and proper relation to each other, it will be seen that the proper relative position of the round hole in the sleeve, the lever, and the broached hole is always secured. They have in course of construction for the gun department a machine for boring 33-pound guns. This machine will be 40 feet long, but will embody the same general principles as are used on the smaller ones. They are also building a rifling machine for the same gun, which will be 40 feet long, and will weigh about nine tons, being the largest rifling machine yet built in this country.

On one of their large gear cutting machines we noticed an attachment for cutting internal gears. It consisted of a head fitted to the cross-slide, in place of the usual head which carries the cutter, and fitted with two shafts connected by miter gears. The driving pulley is on the end of one shaft, and the cutter is at the end of the other. This latter shaft or spindle is so situated as to lie in a line radiating from the center of the gear to be cut, and carries a stem cutter of the proper shape.

They are now making these machines so that a worm wheel which is being "hobbed out" can be driven positively at the proper speed, independent of the hob, thus enabling any desired amount of clearance to be obtained with any hob, and enabling certain other effects to be produced which would not be easily attainable without it.

Their gauge department is quite busy at present, the adoption and rapid introduction of the Briggs standard for pipe threads and fittings making of itself quite a business.

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Copying Machine Designs.

A well-known inventor and manufacturer, during a conversation with the writer recently, said that one of his greatest annoyances in business was the copyists; machine builders who never originate anything worth building, but who depend upon others to involuntarily furnish them with their designs.

This man has invented and brought out several of the best-known and most useful machines and devices used in machine shops, and spoke quite bitterly of the fact that after spending many days of hard labor over the drawing board, and putting himself to all the expense attendant upon the bringing out of a new machine, including, in some cases, the expense and trouble of educating the public to its use, it was frequently copied with sufficient accuracy to deceive undiscriminating purchasers, and the imitators, being exempt from the expense and labor of origination, and having usually much reduced the standard of workmanship on the machine, were thereby enabled to sell at prices below what he could afford, thus depriving him of what he had justly earned by his labor, skill and investment.

There can be no question but that there is much ground for complaint on this score, and perhaps the worst feature of the case is that there is no plan for entirely preventing it; for, from the nature of the machine business, there must always be more or less copying, or there will be no general advance or improvement. When an inventor brings out a new machine differing essentially from its predecessors, and considerably better and more efficient, he thereby proves to the other builders of such machines that there is a better way; or that they have been building their machine upon a plan which is wrong; and with human nature as it is at present constituted it is hardly to be expected that they will go out of business, or continue to build machines demonstrated to be in a certain sense wrong, and hence they copy, so far as they may be able to do so.

One object of the patent laws is to secure to inventors and designers the reward due to their labor and skill, and of course, in most cases, the protection afforded by them is available, and should be made use of; but still there are a great many new designs constantly being brought out, which, from their nature, cannot well be patented, and it is these upon which the copyist depends.

It is probably safe to say that no machine shop doing a general business can be carried on without doing some copying; progress and improvement in the machine business necessarily involves more or less of it; some one must be the first to make a given improvement, and the others must eventually follow, and, if possible, still further improve.

In the case of a concern employing inventive talent and producing something like its fair share of original improvement worthy of imitation by others, there would probably be little complaint, but there are some who do not do this, but depend for their designs and improvements entirely upon the labor and skill of others, in some cases not even so much as employing a draftsman.

It is true that such a concern can seldom, if ever, produce a machine equal to the original, but unfortunately all buyers do not appreciate that fact, and will buy where they can secure machinery at the lowest price, regardless of the principles of ethics which are involved, and often in lamentable ignorance of their own best interests, and thus the originator is deprived of business which justly belongs to him.

Of course this is an evil, and those who are guilty of it can hardly be called honest. Machinery, after being built, cannot usually be hidden away; it must be sold or used where others will have ample opportunities for seeing it, and the copyist always knows where to go to find it; consequently any attempt at secrecy by the originator, except in the case of machines used solely in his own shop and very closely guarded, only serves to prevent buyers from recognizing the fact that the machine which they buy of the copyist is really a copy, and thus the attempted secrecy is in the copyist's favor, because most machinery buyers will give the originators of a machine the preference over the mere copyist if they can only distinguish between them, and the attempted secrecy only prevents them from making this distinction.

Both reason and experience teach that the best protection against copying, in cases where for any reason the protection afforded by a patent is not available, is the publication of new designs in a mechanical journal of established reputation and wide circulation; by this means the public are made familiar with it and are able to recognize imitations.

There are very few manufacturers who care to become generally known as copyists, and the competition of those who are so indifferent as not to care for their reputation in this respect is not much to be feared.

The illustration and description of any new mechanical device or machine in the columns of a widely circulated journal gives it such publicity as will make any copying of it almost certain to be recognized everywhere, and is a much better protection for unpatented designs than any attempted secrecy.

Most makers of closed heaters expect that the heaters will be blown out and cleaned out at reasonable intervals. In his way a good deal of dirt and scale-making matter are kept out of the boiler, to the advantage of the latter. But the manufacturers of heaters complain, and some recent observations lead us to think, with a good deal of justice, that their directions as to blowing and cleaning out are not complied with.

When a heater is found full of dirt and scale there is evidence that it is not used as it ought to be used. A good heater should do something more than heat the feed-water. It should trap a good deal of dirt that would otherwise find its way into the boiler. The moral seems to be: Blow out and clean out your heater at intervals corresponding to the kind of water you use.

Make Orders Plain.

Some remarks in a recent catalogue of one of the best known machinery manufacturers in the country, regarding the advantages of making orders, especially for special machinery, plain and explicit, are likely to touch a responsive chord in hundreds of machine shop foremen and superintendents. We have not room to quote at length from these remarks, but the following will suffice for a text:

The cost of a job depends more than is sometimes supposed on the way the order is made up. A clear and definite order can be filled without study or hesitation, but if the description is vague, or any details are omitted, the work can be completed only after considerable study and correspondence, and at a great risk of errors and misunderstandings.

A good deal of both time and money are wasted through lack of an understanding or appreciation of the above. Sometimes men who do such ordering are draftsmen themselves, or are shrewd enough to employ the services of draftsmen, and send an intelligible drawing or word picture of what they want. By doing this they save time, money and vexation of spirit. But this is by no means always—hardly generally—the case. Many who order special tools and machinery want something quite different from anything else, and appear to take it for granted that the builder ought to know what they want, without much occasion for explanation. Not infrequently they resent too much inquiry as delaying the work, as well as displaying ignorance. The manufacturer cannot undertake a job until he understands it. And if he must put a mechanical engineer at work for a week or two to find out what the party that orders really wants, he must have pay for his services. This makes provision for a good-sized bill before the work is really begun, and a good deal of time is wasted, so far as advancing the work is concerned.

Many times we have seen sketches—so called—that have been submitted from a distance to manufacturers, from which they were asked to bid for the cost of manufacturing a large number of something—no one could imagine what, from the sketches, without "void or form" or figured dimensions.

It is not uncommon that men apply to a manufacturer to make something, the exact use of which they keep, or try to keep, a profound secret. There may be instances where such a course is advisable, but they are very rare. A lawyer always defends his client, or prosecutes his client's opponent better for knowing all the facts in the case. So the skilled mechanicians employed by the manufacturer serve the ends of his customer better by knowing just what the latter proposes to accomplish with his device.

The subject is capable of almost infinite expansion; there are a thousand men in the country whose hair has been made prematurely gray through indefiniteness in orders.

On page 4 of this issue we publish in part a paper on "Machine Designing," by Prof. Sweet. We would gladly have shortened this paper so as to have completed it in one issue, but we think our readers will agree with us in the opinion that there is nothing in it that could be profitably omitted.

Literary Notes.

WOOLEN AND WORSTED CLOTH MANUFACTURE. Being a practical treatise for the use of all persons employed in the manipulation of Textile Fabrics. By Roberts Beaumont, M. S. A., Lecturer and Demonstrator in the Textile Industries Department of the Yorkshire College, Leeds. New York, John Wiley & Sons, 15 Astor Place.

This work is profusely illustrated, clearly written, and we have no doubt will be appreciated by those engaged in woolen manufacture. So far as we can judge, it is by far the most complete work of the kind yet published.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(217) C. P. M., Memphis, Tenn., asks: Which is the best method of driving boiler rivets, machine, hand or button set? *A.*—Either method is satisfactory if the work is well done. Some prefer one method, others another.

(218) J. G. T., Peekskill, N. Y., writes: Will you kindly inform me how small irregular pieces of steel, such as fine steel watch chains, are polished in quantities? *A.*—We believe it is done by a rattling or tumbling process with polishing material.

(219) P. S., Kent, O., asks: Please give me the solution that produces white lines on a blue ground in blue prints. Also the kind of paper that would be most suitable for preparing with the solution. *A.*—See answer to Question 449, American Machinist, Nov. 5, 1887.

(220) E. G. Jones, Camden, N. J., asks Will you please tell me how the gauge of saws is measured? For instance, gauge 22, does it mean 1-22 of an inch, or 22 parts of something else? *A.*—We referred this question to Henry Disston & Sons, of Philadelphia, who replied that the gauge used by them is the same as the Birmingham gauge, the sizes of the numbers in which you will find in most of the engineering pocket books; 22 is given at .028 inch.

(221) J. M. N., Wissahickon, Pa., writes: Please state in what position the reversing lever of a locomotive engine is set when the engine is running at full speed, and at what length of the stroke does the engine cut off the steam? *A.*—The position of the reversing lever when the engine is running depends upon the weight of train it has to haul, the pressure of steam, grade of the road, and other conditions. As to the point of cut off, that depends upon the amount of lap.

(222) I. D., Chicago, Ill., asks: How can horn be softened and formed into handles, and what kind of moulds should be used? *A.*—Horn may be softened by immersion in hot water for about a half hour. We believe that metallic moulds are used, having a hinge and a screw at the ends of the handles for getting a strong pressure. The horn is cut nearly to shape, put in the mould, and the whole put in hot water, then the horn can be pressed into shape.

(223) G., ——, Ohio, asks: Will you kindly give a graphic description of why you divide the product of the tensile strength into the

thickness of metal by the radius, to get the bursting pressure? I understand that the tensile strength multiplied by the thickness of plate gives the strength of a strip one inch wide, but do not understand how to get at the amount of force exerted on the respective 10, 20, 30, etc. degrees of the circumference to cause rupture, at any point. *A.*—See "Resistance of Cylinders to Bursting Pressure," AMERICAN MACHINIST, Dec. 17, 1887, page 4. The number of degrees never enter the calculation.

(224) L. M. B., West Alexandria, O., asks: Will you please inform me how to make a cement walk? *A.*—If you have a considerable length of walk to lay, our advice would be to employ a competent person to do it for you. Subjects of this kind are out of our line, and the little experience we have had in this direction does not justify us to advise you. 2. Will black diamonds do for yard walks not very much used? *A.*—Yes. 3. Please name some good pocket books suitable for reference in an engine and boiler repair shop. *A.*—Haswell, Trautwine, Nystrom, etc.

(225) J. R., Detroit, Mich., asks: 1. In changing a high pressure engine to a condensing engine, what change is usually necessary in setting the valves? *A.*—Generally none. Sometimes it may be advisable to change the point of cut-off. 2. Is there any saving of fuel effected by using a coil of pipes under boiler to pump through, or by using water grates in which the water is heated from the furnace? *A.*—In a correctly constructed boiler there cannot be much saving—if any—effected by heating the feed water in the furnace or under the boiler, because, whatever amount of heat is absorbed by the feed water, there will be so much less heat for heating the water in the boiler. Your last question relates to subjects out of our line.

(226) R. F., Galveston, Texas, writes: I am a young man, and wish to obtain a thorough education in civil and mechanical engineering, but have not either the time or the means to take a course in a college Now, I want to know if it would be possible to obtain such an education by joining the U. S. Engineers, and also if there are any reasonable chances of promotion in these corps *A.*—In the way we understand it, the U. S. Engineers Corps is made up of graduates from West Point; hence, to become a member of the U. S. Engineers, you will have to take a course in engineering at West Point. Should you wish to enter this college, write to the congressman who represents your district, state your wishes and ask for advice. If you are fortunate enough to obtain admission into the college at West Point, your education will not cost you anything.

(227) Reader, Brooklyn, N. Y., writes: To settle a dispute, what would you do under the following circumstances: Engine and pump running, but through neglect or from some other cause, no water can be found in the boiler? *A.*—The first thing we should do in such a case would be to stop making steam. This can be done by hauling the fire, but generally better by covering it with coal, dirt, or ashes, or all of these. Under all circumstances let the engine continue to run just as it is, and generally the pump. The supposition is that the pump is not quite supplying the boiler, hence, with the engine running, the steam pressure will be gradually reduced, and the water level will fall slightly. If we knew the pump was more than supplying the boiler, which would imply a good deal of previous negligence, we should ease it down until we were sure it was running so as not to increase the water in the boiler. The golden rule is to effectually deaden the fire and to interfere with all other conditions as little as possible; then cool down and examine boiler.

(228) W. J. S., Albany, N. Y., writes: Please give me the correct pressure to press brasses in locomotive driving boxes, to press wheels on axle, and crank pins into wheels. *A.*—Brasses are generally pressed into the boxes with a pressure of 5 to 7 tons. See AMERICAN MACHINIST, page 6, Dec. 24, 1887. The pressure for forcing the wheel center on a driving axle should be about 9 tons for every inch in diameter of axle. See AMERICAN MACHINIST, page 3, Feb. 4, 1888. For pressing the crank pins into the wheel, the pressure should be about 6 tons for every inch in diameter of the wheel fit of crank pin, providing the hole in the crank is perfectly true. If the hole is not perfectly true, which may be the result of shrinking on the tire after the hole for crank pin has been bored, or if the hole is not smooth, the pressure may have to be increased up to 9 tons for every inch in diameter. 2. Are jewelers' files made in this country? *A.*—Yes. 3. Why is black lead mixed in oil for cylinders? *A.*—Because pure graphite or black lead is an excellent lubricant, and is esteemed by many engineers.

(229) S. B. E., Du Bois, Pa., writes: Given a vertical engine with cylinder 2 15-16″×4″, 300 revolutions per minute, and boiler pressure 100 pounds per square inch, how will the following proportions answer? Steam ports ¼″×2″, exhaust port ½″×2″, and bridges 3-16″ wide. *A.*—These ports are large; ¼″×1″ for steam ports, and ½″×1″ for exhaust ports are large enough. You should bear in mind that the piston speed of this small engine is considerably less than the piston speed of the engine to which you refer, and consequently the area of the ports in the small engine is not made as large in proportion to the cross-sectional area of the cylinder. See AMERICAN MACHINIST, Sept. 5, 1885, page 5. The width of bridges should be about equal to the thickness of the barrel of cylinder. 2. How much outside and inside lap will be required? *A.*—That depends upon the point of cut-off, which is controlled by the amount of power you wish to obtain, and which you do not state. If you know the point of cut-off you can find the suitable outside lap by rules given in the AMERICAN MACHINIST, Nov. 21, 1885, page 6. After you have determined the amount of outside lap, you can find the travel of the valve by rules given in the AMERICAN MACHINIST, Oct. 10, 1885, page 2.

(230) H. W. C., Cromarty, Ont., writes: I have been thinking of learning to be a machinist and mechanical engineer. I have been advised by some first to go and serve a term of four or five years in a shop; others tell me that I will save several years by going first to an institute of technology. What is your advice? *A.*—Make your own choice. If you prefer going to college first, go there If you are not competent to make your own choice, you are either too young to learn the profession, or not competent to learn it. So far as we know, the shop you mention is a good shop in which to serve an apprenticeship. 2. Which is the best college for young men to enter to learn mechanical engineering? *A.*—Send to the different colleges for catalogues, and make your own selection. 3. Under all circumstances is the machinist trade a good one? *A.*—If this business interests you more, and gives you a greater pleasure than any other, then it will be the best for you to learn under all circumstances.

(231) Engineer, Fairville, N. B., writes: 1. Would you deem an ordinary return tubular boiler—bricked in—48 inches diameter, with 57 tubes 3 inches in diameter, 144 inches long, grate surface say 16 or 20 square feet, capable of supplying steam at 80 pounds pressure to common slide valve engine, 16 inches diameter of cylinder by 24 inches stroke, running 125 revolutions per minute, developing about 80 indicated H. P.? Engine exhausting into stack, which is 55 feet high, to create forced draft. Fuel, spruce and pine edging and sawdust. *A.*—We believe the boiler to be too small for the purpose Under the conditions given, we should rate it about 60 H. P., although, by good management, it may give sufficient steam to enable the engine to develop 80 horse-power. 2. Does it injure a brick chimney to exhaust into it? If so why? *A.*—It is not advisable to exhaust into the chimney, if it can be avoided, because the moisture of the exhaust must in time injure the brickwork. Yet we have known a brick chimney into which the engine exhausted to have sustained no apparent injury after 20 years of service. 3. I propose making an internally fired boiler, with round fire box made of ¼-inch steel. The fire box is to be 36 inches diameter, 6 feet long, no stays in fire box. What pressure can I safely carry to avoid possibility of fire box collapsing? *A.*—About 30 pounds. 4. What pressure might be carried if the same fire box is made of 5-16 steel? *A.*—About 40 pounds. 5. How many stays should such a fire box have to carry 90 pounds? *A.*—One ⅞ stay bolt for about every 60 square inches. 6. What is the relative efficiency of a pound of anthracite coal compared with the same weight of bituminous lump coal for generating steam? *A.*—One pound of anthracite coal is often reckoned to contain 14,000 units of heat; and one pound of bituminous coal 13,000 units of heat. But as scarcely any two mines yield coal of the same quality, the relative efficiency may be, in some cases, reversed. In a general way, we believe the best plan to be to assume that the efficiency of one is equal to that of the other.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Gear Wheels. See adv., page 16.

Link-Belting.

Send for catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Taper atttachment on all lathes Lodge, Davis & Co.

Compound rest on all lathes Lodge, Davis & Co.

Power cross-feed on all lathes Lodge, Davis & Co.

Large hollow spindle on all lathes Lodge, Davis & Co.

Automatic stop on all lathes Lodge, Davis & Co.

See special ads. pages 15 and 16, Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

Lamb Knitting Machine Co., Chicopee Falls, Mass.

Machine work and pattern making. Anderson Machine Works, Peekskill, N Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

Pattern and Brand Letters. Vanderburgh, Wells & Co , 56 Beekman street, New York.

Solid Nickel-Seated "Pop" Safety Valves. Consolidated Safety Valve Co., 111 Liberty st., N. Y.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Light and fine machinery to order; foot lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Improved fine tools for mechanics, manf'd by L. S. Starrett, Athol, Mass. Send stamp for full list.

Burnham's turbine wheel is sold at net price to mill owners. Catalogue free. Address York, Pa.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Silk wiping towels are better and cheaper than waste. S. A. Smith, 23 South Canal st., Chicago Ill.

The Improved Tabor Steam Engine Indicator, made and sold by The Ashcroft Mfg Co., 111 Liberty st., N. Y.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Robertson's damper regulator; no diaphragms, springs or packing: the cheapest good regulator in market. Hine & Robertson, 45 Cortlandt st., N. Y.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gotttried, 208 Canal st., N. Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

Patent Att'y. R. G. DuBois, 916 F. st., Washington D. C. Reliable service at reasonable rates. Send for 38-page pamphlet containing list of references.

The Holley Manufacturing Company, of Lockport N. Y., will send on application, their pamphlet, illustrating pumping machinery and reports of duty trials

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

New book on gears; ask dealers in books and machinists' fine tools to send for one, or send for one yourself by P. O. note. Price, 50 cents. Address Chas. B. Long, M. E., Worcester, Mass.

Randall's copper-tipped hammers are something that every machinist should have; ask your dealer to show you one, and if he does not keep them, write to Montgomery & Co., 105 Fulton st., N. Y.

W. H. Hoffman, consulting engineer, 94 Liberty st., N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Parties requiring milling machine or screw machine work furnished, in large or small quantities, will please write to the manufacturers, E. E. Garvin & Co , 139, 141, 143 Centre st., New York City.

The Dieble Mfg. Co., Philadelphia, Pa., mfrs. of the Challenge emery grinding and polishing machinery, invite correspondence with all needing this class of machinery. Catalogues and prices on application.

Hot Water Supply. A practical treatise on the fitting of hot water apparatus for domestic and general purposes. By F. Dye. 82 pages, with 25 illustrations. 12mo., cloth, $1. Send for catalogue. E. & F. N. Spon, 12 Cortlandt street, N. Y.

James D. Cardell & Co., 1900 Passyunk ave., Philadelphia, Pa., boiler makers, manufacturers of tanks, stacks, and all kinds plate iron work; coils of wrought-iron pipe for ice machines, blast furnaces, paper mills, dye houses, etc., also coil boilers.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G Co., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including April 7, 1888 issue 47 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton street, New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 61 articles have thus far appeared up to and including the March 31, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING Co., 96 Fulton st., New York.

MANUFACTURES.

The B. C. Bibb Stove Works has been incorporated at Port Deposit, Md.

The Michigan Land Company will build a lumber mill at Evergreen, Ala.

W. A. McCaulers is interested in building a furniture factory at Tupelo, Miss.

The Chickies Iron Company, Chickies, Kan., has increased its capital stock $50,000.

Stewart & Donnell expect to build a foundry and machine shop at Greensboro, N. C.

The Sheffield (Ala.) Manufacturing Company will add more machinery to their lumber mill.

The Southern Pacific R. R. Co. expect to double the capacity of their machine shops at Houston, Texas.

The Henderson Steel and Manufacturing Company expect to build an edge tool factory at Birmingham, Ala.

An addition 50 x 200 feet, four stories high, is being made to the Mississippi Cotton and Woolen Mills at Wesson, Miss.

The Crump Manufacturing Company's sash, door, blind and box factory, West Bay City, Mich., was damaged by fire April 4. It is insured for $8,500, enough to cover the loss, and will be rebuilt.

The buildings of the Leechburg (Pa.) Foundry and Machine Company were recently destroyed by fire, resulting from the buildings becoming filled with gas. The company had just put up two new buildings.

Baxter D. Whitney, builder of wood-working machinery at Winchendon, Mass., is increasing his facilities by the addition of new machine tools to his shops, and contemplates the erection of an additional building this season.

Paul Drelier, of Pittsburgh, Pa., offers to take stock to the extent of $70,000 in bridge building work to be located at Sharon, Pa. It is believed the balance of the required stock will be raised without trouble. The works, if established, will employ 200 men.

The Belknap Manufacturing Company, Bridgeport, Conn., has issued a catalogue of brass and iron steam, gas and water goods. We notice two new devices in this arrangement, viz., the "Jewell" and the "Spray" hose pipes. The catalogue is fully illustrated.

The Ivens & Sons Machine Company, Decatur, Ala., are making a specialty of irrigating pumps, having already placed a large number, and having many more under construction. These pumps are of large capacity, of simple construction, and their use is said to have largely increased the rice crop of Louisiana.

Frank M. Clarkson, exclusive sales agent for the Rice patent feed water heater and purifier, office Detroit, Mich, is represented in New York by William H. Bailey at 41 Dey street. Mr. Clarkson has reports of excellent results from the use of these heaters and pumps combined, certified to by parties using them.

At a meeting of the board of directors of the Hartford Steam Boiler Inspection and Insurance Company, held yesterday, the following officers were elected for the ensuing year: J. M. Allen, president; General William B. Franklin, first vice-president; Francis B. Allen, second vice-president; and J. B. Pierce, secretary and treasurer.

The estate of F. W. Richardson, Troy, N. Y., report good business in the sales of the Richardson and Allen-Richardson balance slide valves. Many leading railroads in the country are using these valves with excellent results. The firm have added new tools in order to keep up with the demands of the trade. This firm also make model link motions and other devices.

C. E. Clark, of Rochester, N. H., has sold one-half interest in his machine shop to J. C. Furnell, formerly with Somersworth Machine Company, Dover, N. H. New tools will be added to the machine shop and a foundry built at once. They will build exhaust fans for saw mills, boiler feed pumps, shafting hangers, pulleys, gears, etc. Hereafter the works will be known as the Rochester Foundry and Machine Company.

New water-works, or the enlargement of existing works, are contemplated at Winsboro, S. C.; South Center, Kan.; Greenport, L. I.; Chadron, Neb.; Albany, N. Y.; Monmouth, Ill.; Franklinville, N. Y.; Carterville, Mo.; Orono, Me.; Washington, Kan.; Batesville, Ark.; Warrior Station, Ala.; Wakefield, Can.; Denton, Tex.; Helena, Mont.; Scotland, Dak.; Chetopa, Kan.; Santa Cruz, Cal.; Franklin, N. H.; Webb City, Mo.; Edgar, Neb.; Uniontown, Pa.; Madison, Fla.; Moundsville, W. Va.

The Utica *Herald* says: "The new pulp mill and paper mill which it was expected would have been commenced before this on the Rawson site near Carthage, N. Y., has been delayed on account of the company not being able to get possession of about one-sixth of an acre, mostly rock, which was owned by an old lady in Chicago, who has a life lease of it, and whose place of residence was not ascertained till recently. Interested parties are now in Chicago to buy off her lease, and as soon as this is accomplished, operations will at once be commenced."

The Brown & Sharpe Manufacturing Company, Providence, R. I., have issued a new edition of their famous "blue" catalogue. It is materially enlarged from any previous catalogue issued by the firm, containing illustrations of new machines and tools. This catalogue has long been a favorite with mechanics, because, in addition to a description of tools and machines, it gives a good deal of information of general value. The catalogue is sent free upon application; we advise every mechanic to send for one, and upon its receipt to destroy his old catalogue.

A correspondent of the *Manufacturers' Record* writes from Winchester, Tenn.: J. B. Rosenberger, T. E. Umstead and J. W. Baker, three Northern capitalists, have purchased over 2 500 acres of long leaf virgin pine near Jasper, Ala., and will put up a large saw and planing mill at Jasper to manufacture all kinds of dressed and rough lumber. Will begin operations in about 30 days. An entire outfit of machinery will be needed. We intend to build railroad to timber and haul logs with engine. Expect to do a large business.

The City of Chicago, Ills., has awarded the contract officially to Edw. P. Allis & Co., of Milwaukee, Wis., for five new triple expansion condensing pumping engines, of the same design as the new "West Side Plant," recently built by that firm for the city of Milwaukee, which were the first engines of their type constructed in the country. The capacity of the Chicago engines will be 15,000,000 gallons of water per 24 hours each—a total of 75,000,000 gallons a day. One of the engines will be located at the Harrison street station, and the other four at the new pumping station on Indiana avenue and 14th street. The total cost will be about $400,000. The competition for this contract was sharp.

Machinists' Supplies and Iron.

New York, April 12, 1888.

Trade has continued in the same unsatisfactory condition, the fresh business transacted having been of limited proportions. We quote good brands of No. 1 X Foundry at $20 to $20.50, according to delivery; No. 2 X Foundry $19 to $19.50, and Gray Forge, $16 to $16.50.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to sell planes, see page eleven.

Wanted—Position as draftsman; best references. Box 92, American Machinist.

Wanted—Position as foreman pattern maker; best references. Box 91, American Machinist.

Wanted—In Philadelphia, a good mechanical draftsman. Address K. W., Am. Machinist.

Wanted—Foreman machinist for new work and repairs; 30 machinists employed. Box 94, Am. Mach.

Young man, 18, first-class education, wants position as apprentice in a machine shop. Address G., Am. Machinist.

A young man wishes a situation; is a thorough machinist, tool and die maker, also draftsman. Address W. H., Am. Machinist.

Wanted—Foundry foreman for general machine work. Address, stating age, experience, salary expected and references, B. B., Am. Machinist.

A mechanical draftsman, experienced on machine tools and special machinery, wishes position; shop experience; best references. H. O., Am. Mach.

Wanted—To purchase partnership in sound engineering concern, marine preferred, by a good draftsman and machinist. Box 96, Am. Machinist

Wanted—Situation as foundry foreman, 14 years' experience on engine machinery and jobbing; first-class references. M. D., Box 407, Cuyahoga Falls, O.

Mech. draftsman. A young man, technical school graduate, experienced designer and machinist, wishes to change situation in May. C. E., Am. Machinist.

Wanted—Draftsman on printing machinery; permanent employment if satisfactory. Address. Golding & Co., Boston, stating age, experience and pay required.

Wanted—By a young man, position as foreman for a machine shop; no objection to the West or the country; first-class machinist. W. B. A., 1616 N. Caroline street, Baltimore, Md.

Wanted—Foreman for blacksmith shop. Must be thoroughly up to die and tinner's stake forging, steel melting, etc. A first class opportunity for the right party. Address Niagara Stamping & Tool Co., Buffalo, N. Y.

Active, influential men, capable of dealing with principals, who can introduce the Edson steam gauge to the notice of steam users in their vicinity For particulars address Jarvis B. Edson, 91 Liberty street, New York.

Wanted—Position as machine shop superintendent by first-class designer and draftsman, with extensive and varied experience in steam engine, locomotive, marine and mining work, etc. Address Wm. Y. Silver, Box 8, Trinidad, Col.

Draftsman—A practical man with some experience at drawing and a technical education wants a position where he can be under a good mech. engineer and get valuable experience as well as moderate pay. Address R. D., Am. Machinist.

Designer and draftsman, able to design a new line of first-class machine tools, drop hammers, turbines, hydraulic motors hydraulic rams, centrifugal pumps and mechanical specialties, desires engagement. Address R. P., 225 Erie St., Cleveland O.

Wanted Partner—A splendid opportunity to a machinist or pattern maker who can furnish tools for machine shop in connection with foundry in successful operation, situated in the center of a sugar growing region, an extensive lumber manufacturing town; no foundry within 100 miles. Address Box 107, Plaquemine, La.

Wanted—A party to act as superintendent, with $10,000 to invest in a prosperous Western manufacturing plant, and take an active interest in the business on a fair salary; must be a practical machinist and one with experience in steam machinery preferred; paid-up capital, $50,000, with $10,000 surplus. Address Capital, Am. Machinist.

Wanted—Foreman for a large foundry in North Alabama; also foreman for pattern shop, and bookkeeper for the works. The capital stock of the company is one hundred thousand dollars, and the works in active operation. Each person will be required to take from 3,000 to 5,000 stock in the company. Address P. O. Box P, New Decatur, Ala.

✢ MISCELLANEOUS WANTS. ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

The Cyclone Steam Flue Cleaner is king, and has no rival. Crescent Mfg. Co., Cleveland, Ohio.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland, Ohio.

Wanted—Parties having machinery specialties to build, to correspond with. Box 75, Am. Machinist.

Hard rubber blowing and pressing dies and machinery a specialty. E. O. Chase, Newark, N. J.

Adamantine adhesive for making steam joints; stops leaks in boilers, stops piting. Chas. Barnes & Co., Cincinnati, Ohio.

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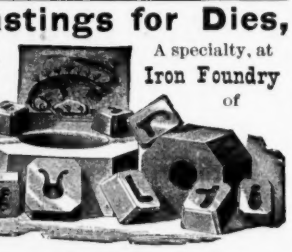

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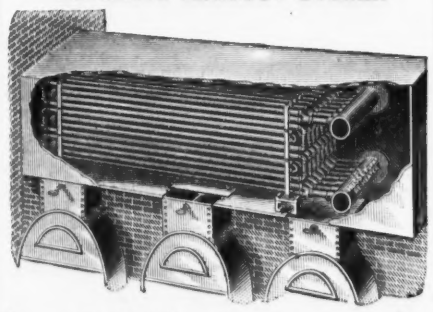

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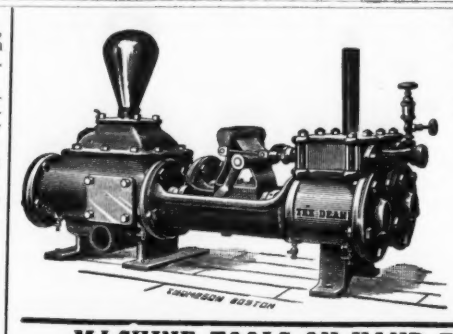

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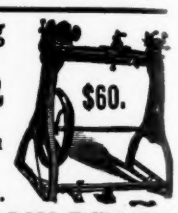

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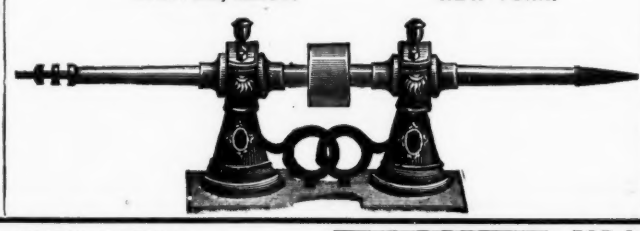

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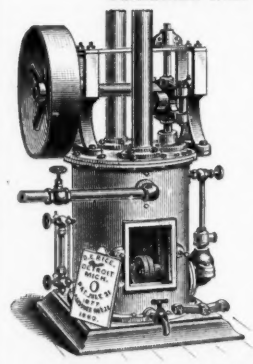

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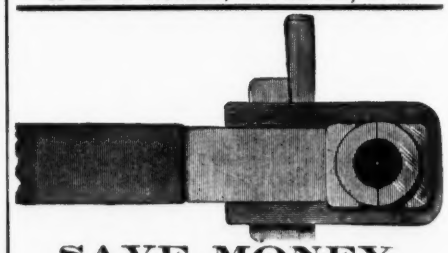

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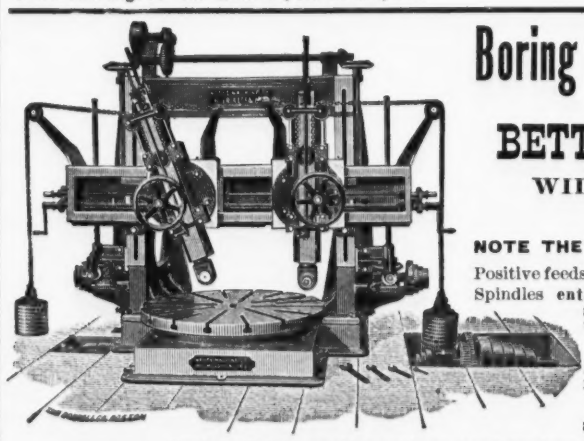

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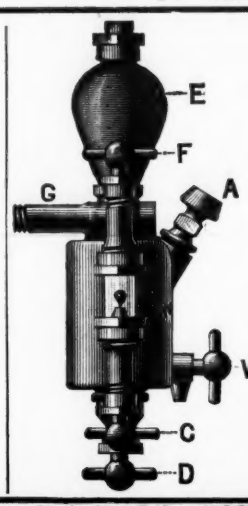

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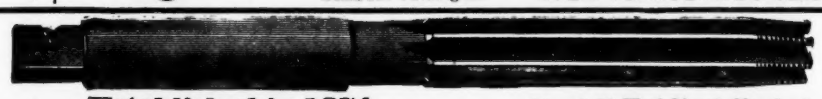

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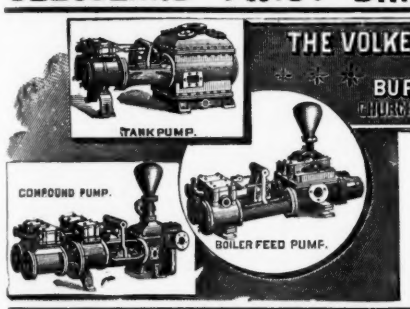

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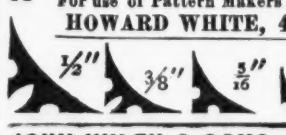

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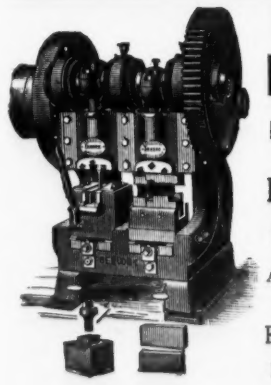

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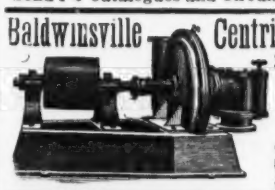

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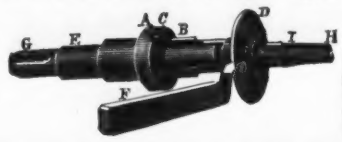

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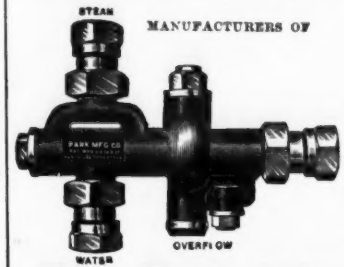

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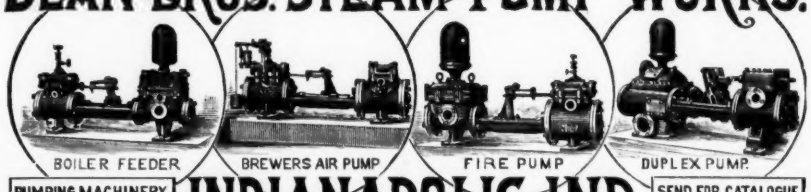

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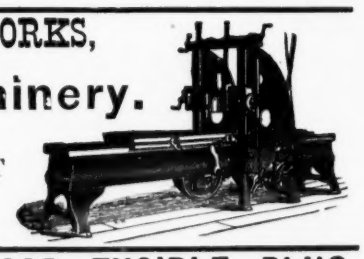

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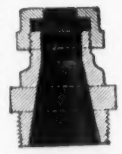

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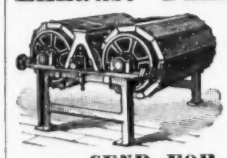

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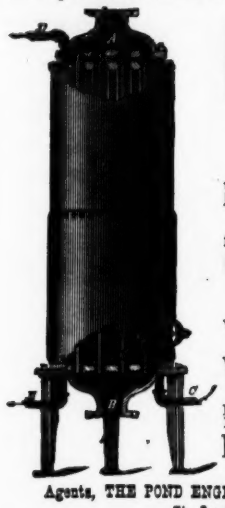

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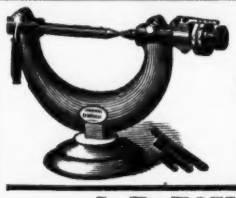

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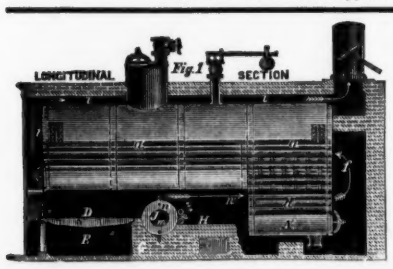

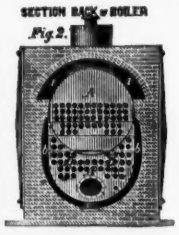

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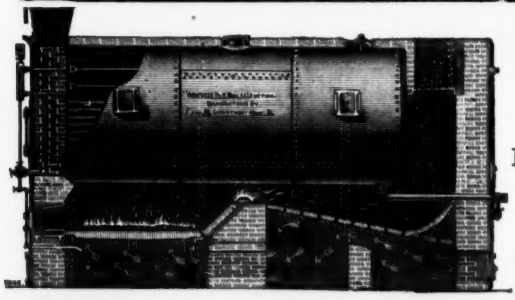

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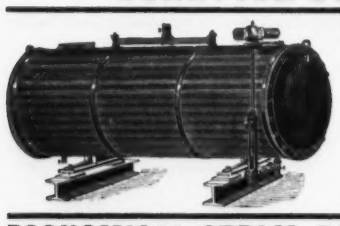

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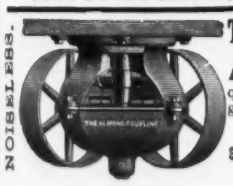

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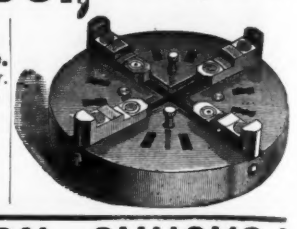

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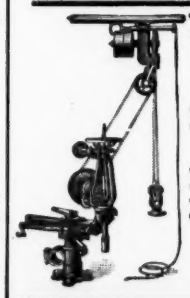

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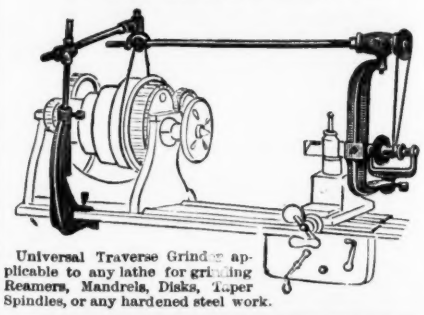

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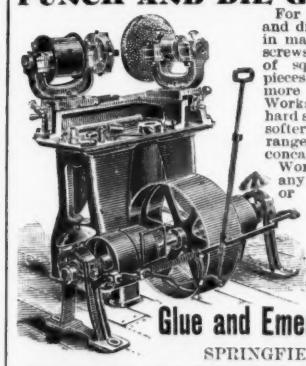

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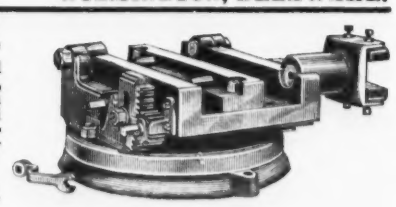

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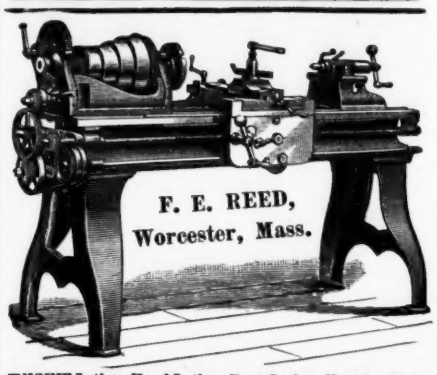

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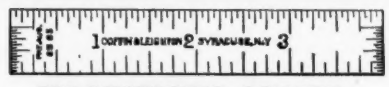

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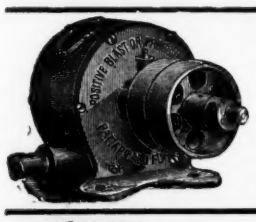

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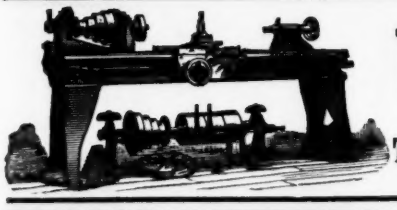

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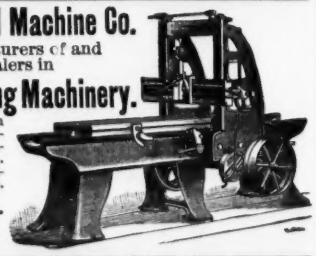

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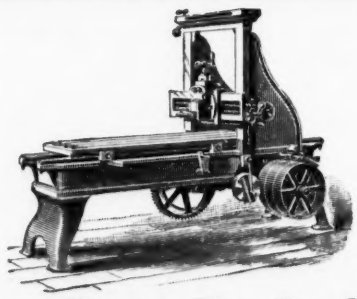

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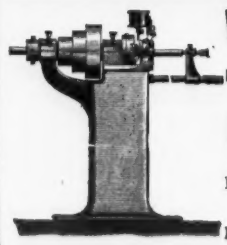

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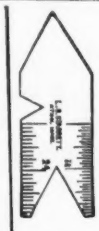

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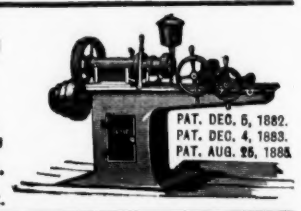

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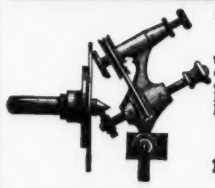

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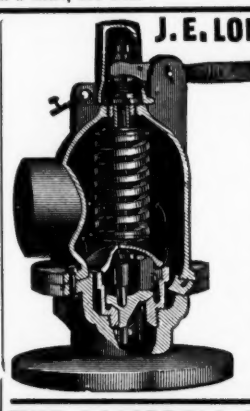

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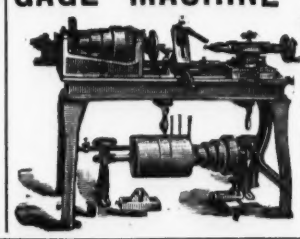

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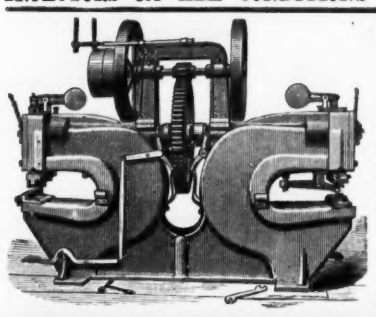

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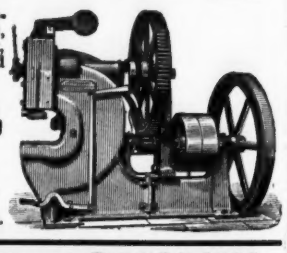

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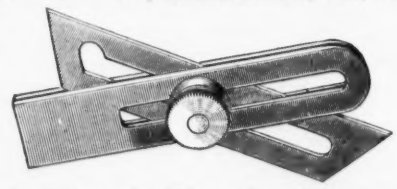

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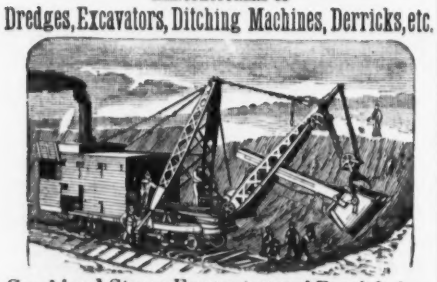

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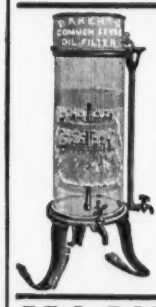

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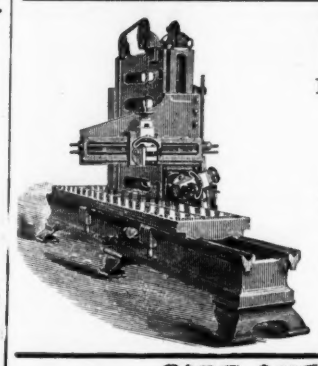

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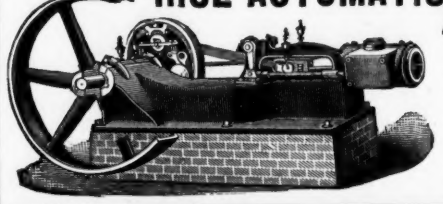

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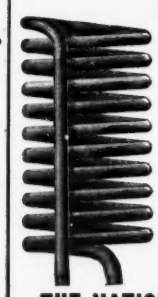

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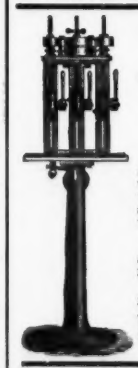

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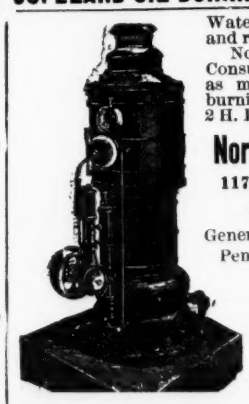

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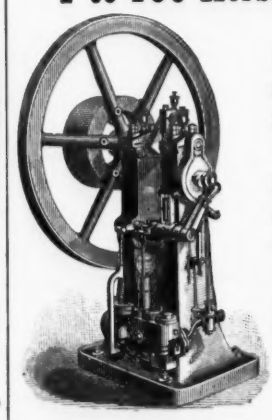

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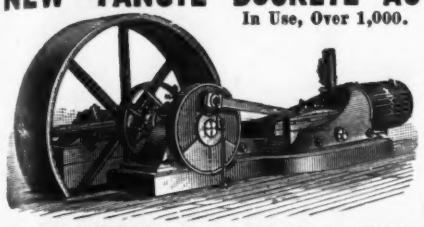

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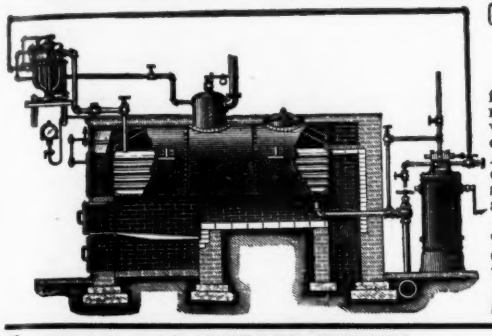

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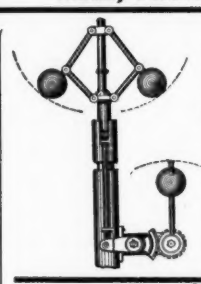

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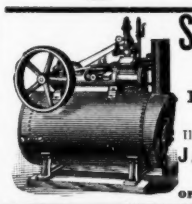

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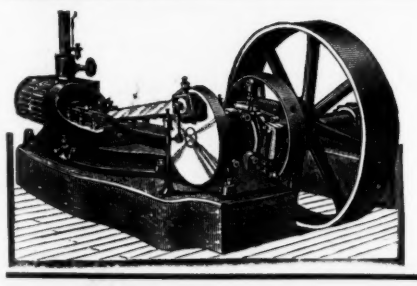

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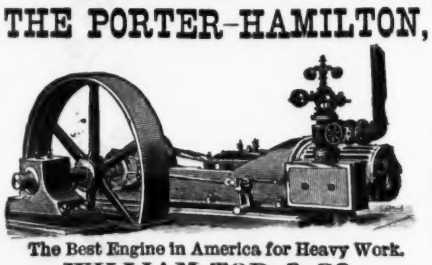

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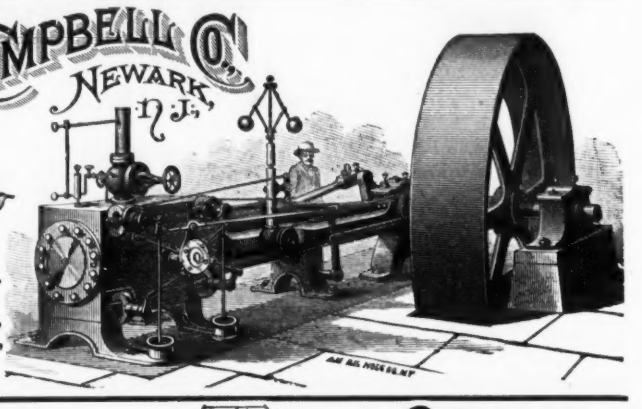

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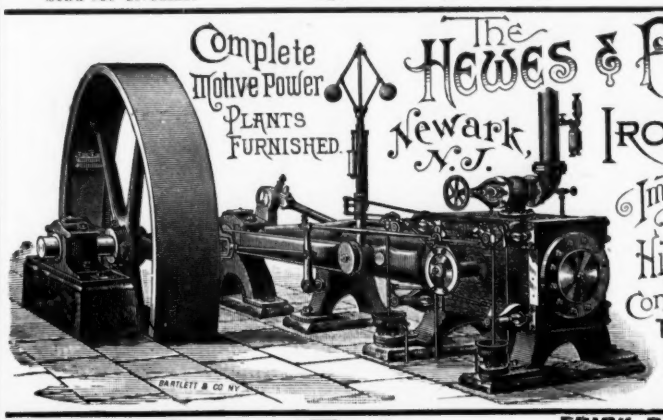

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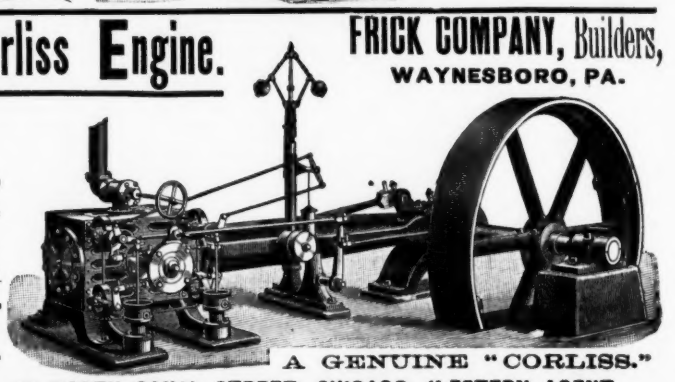

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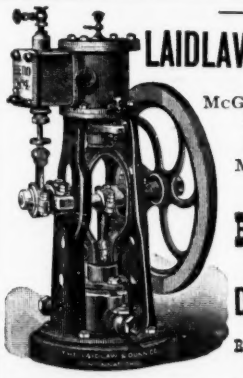

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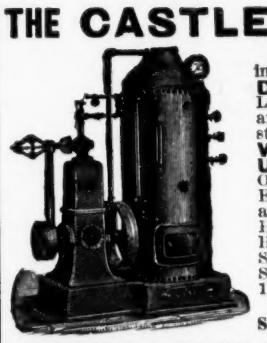

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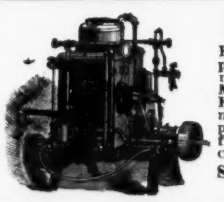

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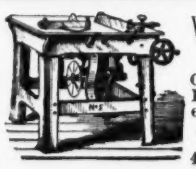

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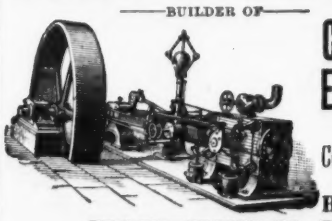

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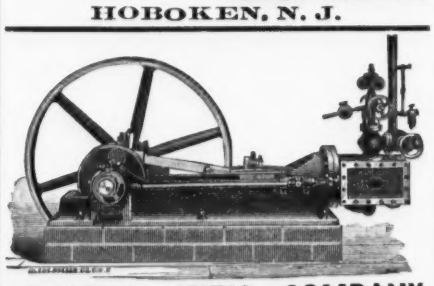

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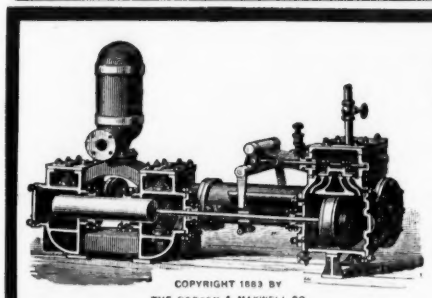

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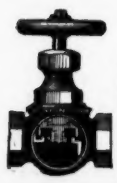

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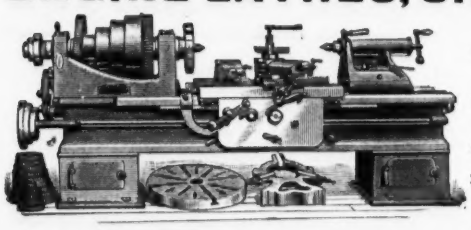

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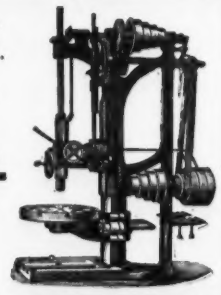

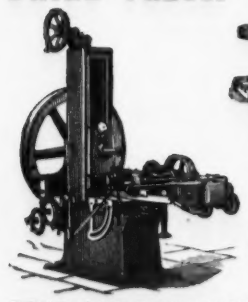

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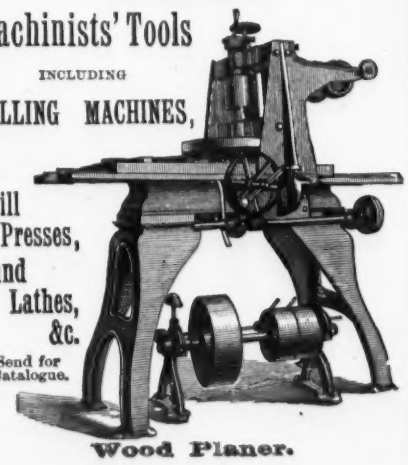

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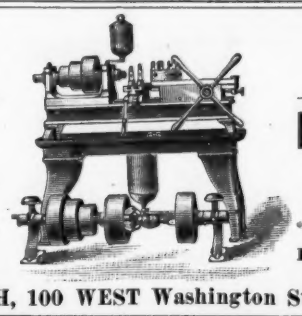

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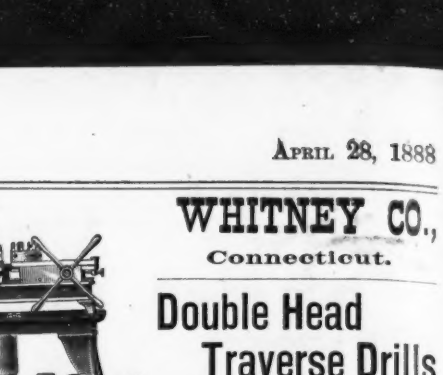

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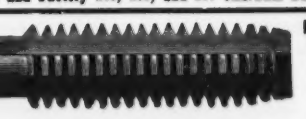

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